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A TEXT-BOOK

OF

OPERATIVE DENTISTRY.

BY

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WRITTEN BY INVITATION

OF THE

NATIONAL ASSOCIATION OF DENTAL FACULTIES.

THREE HUNDRED AND THIRTY ILLUSTRATIONS.

PHILADELPHIA:
P. BLAKISTON, SON & CO.,
1012 WALNUT STREET.
1889.

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F48

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Press of Wm F. Fell & Co.,
1220-24 Sansom St.,
Philadelphia.

PREFACE.

For many years the author has felt that there was need of a text-book on Operative Dentistry, that should be confined more especially to the descriptions of the manual operations required for the preservation of the natural teeth.

This volume is the result of this feeling, quickened by the invitation of the National Association of Dental Faculties to undertake the work.

With what success it is accomplished, the future will determine. The author hopes that it may at least serve as one step toward the production of something that shall serve the purpose fully. The effort has been made to avoid unnecessary detail and to leave out all that could be dispensed with, consistently with clearness.

Hence History has not been attempted, and only enough of definitions, etiology and symptoms of diseases given to make clear the description of the operation to be performed. While intending to include the principles involved in all ways of performing each operation, repetitions under the heads of different methods have been avoided, and authors' names have been generally omitted from the text.

The work is not intended as a substitute for larger works, but as an epitome of the practical application of the principles discussed at length in more extensive volumes, and to these the student is referred for exhaustive discussion.

The most advanced nomenclature has been adopted as far as professional sentiment would sustain the author.

Canine has been left for dogs and cuspid constantly used. Tartar has been discarded as unscientific, and calculus substituted. Hypercementosis seems to fully express the con-

ditions of the cementum so long called exostosis, which seems applicable only to affections of true bone.

Phagedenic pericementitis has been adopted as the scientific name of the condition known as Riggs' disease; this has been pointed out as the one condition that obtains throughout the progress of the disease and seems eminently suitable and correct.

The author desired to substitute lingual for palatal as applied to the upper teeth, but so many expressed dissent that the latter term is sustained.

There has been so much change in respect to nomenclature, it was thought best to insert articles on anatomy and physiology, so that those parts of the subject should correspond with the nomenclature used in the subsequent pages of this book. Similar reasons apply to the writing of several other portions of the work. With few exceptions, all of the first and second parts have been written expressly for this work. The third part on Crown and Bridge work is necessarily largely a compilation. The introduction of this work is too recent, and the methods of construction too diversified, to make possible any definite system which should appear unquestionably better than all others.

This work is classed as Operative Dentistry as it is all dependent upon the natural teeth for support, and may all be done at the operating chair, and almost all of it is much better done with the patient present.

All Operative Dentistry is mechanical, and crown work is no more so than filling a cavity, applying a medicine or injecting an abscess. It was the opinion of a large majority of the Dental Faculties that it should be properly considered as belonging to Operative Dentistry, and in dental societies it has been by common consent considered as such.

The limited time the author could devote to writing of this work would have been found entirely inadequate for the task, but for the clerical and literary assistance rendered by his professional friend and former pupil, Dana W. Fellows, M. D.

The portions treating of the Anatomy and Physiology of the teeth and contiguous parts and deciduous and permanent dentition were written entirely by him, and much critical assistance rendered throughout the book.

Prof. Frank Abbott, M. D., also gave the author valuable help by making careful and extended notes on the manuscript.

Important suggestions were made also by Profs. S. H. Guilford, A.M., D.D.S.; E. T. Darby, M.D., D.D.S.; C. N. Pierce, D.D.S.; A. H. Fuller, M.D., D.D.S.; T. E. Weeks, D.D.S.; Edmund Noyes, D.D.S.; H. W. Morgan, M.D., D.D.S.; S. W. Dennis, M.D., D.D.S.; T. H. Chandler, D.M.D., and Wm. H. Atkinson, M.D.

Thanks are due to the S. S. White Dental Manufacturing Co. for the use of so many of their electrotypes for the excellent illustrations appearing in these pages, also to the publishers of the "American System of Dentistry," and to Claudius Ash & Sons, of London, for like favors.

THOMAS FILLEBROWN.

Boston, December 15th, 1888.

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OPERATIVE DENTISTRY.

THE ALVEOLAR PROCESSES AND ARTICULATION OF THE TEETH.

For a description of the bones of the face the student is referred to works on anatomy.

By the form of articulation known as gomphosis, the teeth are implanted in the alveolar processes, portions of the maxillary bones, which in regard to their development, form and duration are entirely subservient to the teeth. These portions of the maxillary bones, with which the teeth have so intimate a connection, and which have so many important relations to operative dentistry, should receive special attention. These are best described as consisting of two plates of bone, an outer and an inner plate, the alveoli being formed by septa passing across between the plates.

The outer plate, continuous with the facial surface of the maxillary bone in the upper jaw, is very thin, and marked by eminences corresponding to the alveoli which contain the roots of the teeth, that over the cuspid being specially prominent, and known as the canine eminence, behind which is the canine fossa, and in front the incisive or myrtiform fossa.

The inner plate is much thicker and stronger and merges into the palate processes. After extraction of the teeth of the upper jaw, the thin external alveolar plate is absorbed more quickly and to a greater extent than the inner.

In the lower jaw the external plate is thick and strong, except in front, and after extraction of the teeth the absorption of the two plates is nearly uniform.

The socket for each tooth conforms exactly to the root or

roots which it contains, and consists of a thin shell of dense bone, which is surrounded by spongy tissue, and is continuous at the free margin with the dense cortical bone of the jaw. The walls are perforated by numerous foramina, and at the bottom of each alveolus or each division is a larger foramen for the transmission of vessels and nerves to the dental pulp and pericementum. The bony septa between the alveoli rise to a higher level on the teeth in both jaws than the outer and inner walls. This should not be forgotten in the fitting of bands and crowns to the roots of teeth.

OCCLUSION OF THE TEETH.

In the normal human denture the teeth are arranged in a parabolic curve; every tooth touches those at each side, and the cusps and cutting edges of all are on nearly the same level. The plane of the grinding surfaces of the molars rises a little, however, from the first to the third, so that, viewed from the side, a gentle curve is seen, with the concavity directed upward.

The arch of the upper denture is a somewhat larger curve than that of the lower, and in normal occlusion the upper front teeth shut over and in front of those of the lower jaw. The bicuspids and molars of the upper jaw also project beyond the corresponding lower teeth, so that the buccal cusps of the latter, in the closure of the mouth, come between the buccal and lingual cusps of those above.

It will be seen, also, that no tooth in either denture is exactly opposed to any one in the other, but that in normal occlusion each tooth comes in contact with two in the opposite jaw, except the upper third molar, which, being smaller than the lower third molar, occludes with the posterior two-thirds of this tooth, and the inferior central incisor, which is opposed to the superior central incisor only.

By the arrangement thus briefly described the cusps of the bicuspids and molars of either jaw shut into the depressions between the cusps of the teeth in the opposite jaw, thus securing a firmer occlusion and greater efficiency in mastica-

tion than could otherwise be obtained. Moreover, if any one tooth be lost, those in the opposite jaw will still retain a partial occlusion with the contiguous teeth.

THE DENTAL TISSUES.

Three kinds of calcified tissue—dentine, enamel and cementum—enter into the structure of a human tooth, and these, though not absolutely peculiar to the teeth, are appropriately called dental tissues.

Dentine incloses the pulp chamber and makes up the greater part of the tooth. That portion above the neck is invested with a layer of enamel of varying thickness, and is described as the crown of the tooth, while a layer of cementum covers the root and usually overlaps the enamel to a slight extent. If the two last-named tissues be entirely removed, the dentine will still show the general form of the tooth, reduced in size and with the extremities of the roots and cusps quite thin and pointed.

As to its physical properties, dentine is hard, dense and highly elastic, yellowish-white in color and somewhat translucent, fractured surfaces showing a silky lustre.

Chemical analysis of perfectly dry dentine shows it to consist of about 28 per cent. animal and 72 per cent. mineral matter, the latter being mostly phosphate of lime. About 10 per cent. of the fresh tooth is water. The constituents vary, not only in different individuals, but probably in the same individual at different ages and under different conditions.

The structural elements of dentine are the matrix, richly impregnated with calcareous salts, the dentinal tubes, and the soft fibrils. Each tube passes, with some variation in direction and curvature, from its opening on the wall of the pulp cavity toward the surface of the dentine. These tubes contain the soft fibrils, which are prolongations of the cells at or near the surface of the pulp.

Enamel.—Well-formed enamel is by far the hardest of all animal tissues, containing also the smallest proportion of or-

ganic constituents—from 3½ to 5 per cent. Nearly 90 per cent. is phosphate of lime.

Human enamel is translucent, pearly-white in color, with often a tinge of yellow.

In structure it consists of enamel fibers or prisms, hexagonal in shape and in very close apposition, if not in actual contact. The course of these is, in a general way, from the dentine outward, at right angles with its surface. Enamel has a definite cleavage, the line of fracture passing not between the prisms, but through their centres.

Cementum.—This tissue is in all respects very much like true bone. It differs from bone in having lacunæ more variable in size and form, and canaliculi in greater number and of greater length. When the cementum is very thin, as at the neck of a tooth, it is apparently structureless.

Pericementum.—This membrane covers the root of the tooth, lying between it and the bony socket. It serves as a means of attachment and a medium of nutrition to the cementum, and also acts as a cushion to lessen the shock of occlusion. It consists of fibrous connective tissue, and is richly supplied with vessels and nerves. It is thicker near the neck of the tooth, where it is continuous with the gum and periosteum of the alveolar process. It is also thicker nearer the apex of the root. The direction of the fibers is obliquely across from the alveolar wall to the cementum, and, although the membrane varies histologically in different parts of its thickness, it is probably but a single membrane.

THE DECIDUOUS AND PERMANENT DENTITIONS.

Man, in common with most mammals, is provided with two sets of teeth, known as the deciduous and the permanent set.

The deciduous teeth, which are adapted to the requirements of childhood, are fewer in number and, as regards teeth of the same class, smaller than their successors. They constitute the dental apparatus of the child from the time of their eruption to the age of six years, when the first permanent molars ap-

pear. The teeth last named are thus accessory, as regards function, to the deciduous dentition, though anatomically they are quite distinct, and have relations entirely with the permanent set.

Formula of the deciduous dentition—

$$d\ i\ \tfrac{2}{2},\ d\ c\ \tfrac{1}{1},\ d\ m\ \tfrac{2}{2} = \tfrac{10}{10} = 20.$$

The ten anterior permanent teeth in each jaw replace the deciduous teeth, while the twelve molars appear posterior to these and have no predecessors.

Formula of the permanent dentition—

$$i\ \tfrac{2}{2},\ c\ \tfrac{1}{1},\ p\ m\ \tfrac{2}{2},\ m\ \tfrac{3}{3} = \tfrac{16}{16} = 32.$$

In both deciduous and permanent dentitions the teeth are symmetrical on the two sides of each jaw, and equal in number though not symmetrical in the two jaws.

Eruption of the Teeth.—The time of eruption of the deciduous and permanent teeth is subject to great variation, hence tables prepared by different observers do not agree. It is believed that the following tables are correct for the usual or average age at which the several classes of teeth appear:—

DECIDUOUS.		PERMANENT.	
Incisors, inferior and superior,	5 to 8 months.	First molars,	6 years.
First molars	14 to 16 "	Incisors,	7 to 8 "
Cuspids,	17 to 20 "	Bicuspids,	9 to 10 "
Second molars,	20 to 30 "	Cuspids,	11 "
		Second molars,	12 "
		Third molars,	16 to 25 "

The lower teeth in each dentition appear a little earlier than the upper.

Periods of Dentition.—A comparison of the above tables will show that the first dentition is completed at the age of two and a half years. These twenty teeth exercise their functions during the three or four years that follow; at six years of age the first permanent molars appear, and the child then has twenty-four teeth; during the six years between this period and the age of twelve the deciduous teeth are all replaced by their permanent successors, and the second permanent molars

are erupted, so that during the next six years the mouth contains twenty-eight teeth; finally, at eighteen, often not until much later, the second dentition is completed by the eruption of the third molars.

Classes of Teeth.—The teeth in each set are classified and named with reference to their form and relative position in the mouth. Thus, the permanent teeth are divided, with reference to their form, into four classes, namely, incisors, cuspids, bicuspids and molars. Those in the upper jaw are described as the superior or upper teeth, and those in the lower jaw as the inferior or lower teeth. They are further designated as right or left, according to the position they occupy with respect to the median plane of the body. In each of these divisions, namely, superior right and left and inferior right and left, are two incisors, one cuspid, two bicuspids and three molars. The incisors are usually distinguished as central and lateral, but first and second incisor is better, as with the bicuspids which are known as the first and second, and the molars as the first, second, and third, the first being in all cases the anterior tooth of the class, or, in other words, the one nearest the median plane following the line of the dental arch.

Anatomical Divisions of a Tooth.—For description each tooth is divided into *crown*, *neck* and *root*.

The *crown* is that part which is covered with enamel, and which in a normal tooth fully erupted is seen above the gum.

The *neck* is a slight constriction immediately below the margin of the enamel which is closely embraced by the free margin of the gum. This anatomical division of the tooth merits careful study on account of the important relations it bears to the operation of extraction and to the fitting of bands and porcelain crowns.

The *root* is implanted in the bony socket and includes all below * the neck.

* The terms above, below, etc., have reference to the crown and root extremities of the tooth; thus, the term above, signifies toward the cutting or grinding surface of a tooth, and below, toward the apex of the root.

Surfaces of Teeth.—The surfaces of teeth are named from their relations in the mouth to each other and to other parts.

Labial and *buccal* surfaces are those which present toward the lips and cheeks, the term labial being applied to incisors and cuspids, and buccal to bicuspids and molars in either jaw.

Lingual surfaces are those on all the teeth in both jaws presenting toward the tongue or the cavity of the mouth. This surface on the upper teeth is more commonly called *palatal.*

The labial and buccal surfaces are sometimes called *external* and the lingual *internal.*

Proximal surfaces are those which are next to each other in adjoining teeth of the same jaw.

Mesial surfaces are those proximal surfaces which present toward the median line of the dental arch.

Distal surfaces are those on the opposite side of the tooth to the mesial, or presenting from the median line of the arch.

As applied to bicuspids and molars, *anterior* is synonymous with mesial and *posterior* with distal.

Cutting edges pertain to incisors and cuspids and grinding or *occluding* surfaces to bicuspids and molars.

For more accurate description, combinations of the terms given above are used. Their form will explain their signification, as labio-mesial angle, the angle formed by the union of the labial and mesial surfaces. These terms are properly employed with reference to the roots as well as to the crowns of teeth.

Description of the Permanent Teeth.—*Superior Central Incisor* (Fig. 1, A, p. 22).—The crown of this tooth is chisel-shaped. The cutting edge, which is the broadest part, is nearly straight across, but is a little more rounded at the distal angle than at the mesial. In recently-erupted incisors the cutting edge is divided into three nearly equal parts by two slight notches, which soon disappear by wear when the tooth comes into use. The middle point of the cutting edge is on a line with the long axis of the tooth.

The labial surface is somewhat quadrangular in outline, convex in all directions and usually quite smooth, though sometimes two shallow grooves run from the cutting edge to the cervical border. The cervical border is formed by the curved edge of the enamel at the margin of the gum, the concavity of the curve looking toward the crown of the tooth.

The palatal surface is concave and often somewhat grooved longitudinally. The cervical border is formed by the cingule, a more or less prominent ridge of enamel which is continuous at each side with the proximo-palatal borders, and near the cingule on the palatal surface there is frequently a pit or other imperfection in the enamel.

The proximal surfaces are triangular, having the base of the triangle at the cervical border and the apex at the cutting edge. The enamel border on these surfaces is somewhat V-shaped with a rounded angle, the latter being directed toward the cutting edge of the tooth. The distal surface is a little more convex than the mesial, and a little shorter.

The neck of a central incisor is nearly cylindrical, with a tendency toward a triangular form, broader toward the labial side, and the root nearly conical and usually quite straight.

Superior Lateral Incisor (Fig. 1, B, p. 22).—The crown is similar in form to that of the central, but it is in every respect smaller. The form of the cutting edge is less constant, but the angle at the mesial side is usually acute, and the distal side much rounded off. This gives to the labial surface an irregular outline, with the mesial border longer than the distal; this surface is slightly convex in all directions, with the cervical border curved like that of the central.

The palatal surface is a little flatter than that of the central, but the cingule is usually more pronounced, and the pit near it is more constant and deeper.

The proximal surfaces correspond in general form to the same surfaces of the central, but the mesial surface is less convex and the distal rather more so.

The neck is much flattened mesio-distally, and the same form

is retained throughout the whole extent of the root, which is often bent near the apex toward the distal side. The root is slender and longer in proportion to its size than that of the central.

To determine to which side a superior incisor, either central or lateral belongs, let the student hold the tooth with the crown downward, and looking at the labial surface, if the longer border and more acute angle of the cutting edge be toward his right, it is a right tooth, if toward his left, it is a left tooth.

Superior Cuspid (Fig. 1, C, p. 22).—The superior cuspid is the longest tooth in the entire series. The crown is thick and strong, having a single rounded cusp in a line with the long axis of the tooth. The slope from this to the mesial surface is shorter than on the distal side.

The labial surface is convex, especially from side to side, with a rounded, longitudinal ridge running its entire length, and on each side of this a slight depression.

The palatal surface has a similar ridge with a depression at each side, or it is irregularly convex, with the cingule thick and often prominent.

The distal surface is a little more prominent and a little more rounded than the mesial. The form of the neck in section is triangular, with angles much rounded, the root becoming somewhat more flattened, with a groove at each side. The root is also thick and considerably longer than the roots of the incisors.

Hold the tooth as directed for an incisor, and the shorter slope from the point of the cusp to the proximal surface will indicate the side to which the tooth belongs, the shorter side being the mesial.

Superior Bicuspids (Fig. 1, D, E, p. 22).—By some writers these are called premolars.

The grinding surface supports two cusps of nearly equal length, that on the palatal side being regarded as the cingule before mentioned developed into the prominence of a cusp. The buccal cusp is thicker and stouter. This surface presents

an outline somewhat quadrilateral in form; the palatal border, however, is much rounded, while the buccal portion is broader and the angles distinct, giving to the tooth, at the base of this cusp, its greatest diameter from the mesial to the distal surface. The two cusps are separated by a distinct fissure which is nearly straight, and is limited at each end by ridges of enamel at the mesial and distal borders, the mesial border being higher than the distal in all the bicuspids.

The buccal surface is strongly convex in all directions and similar in outline to the corresponding surface of the cuspid.

The palatal surface much resembles the buccal, but it is not as broad and is more rounded from side to side.

The proximal surfaces slope toward each other from the grinding surface, so that at the neck these surfaces are nearly or quite flat, or even concave.

A cross section at the neck shows an elongated outline, often a little constricted at the middle by the beginning of the grooves which pass down the mesial and distal surfaces of the single flattened roots. More frequently, however, the first superior bicuspid has the root divided into two for one-third of its length. Sometimes the root of the second, also, is divided to some extent. The crown of the second bicuspid is usually a little larger than that of the first, the palatal cusp being more fully developed and often as long as the buccal.

To determine to which side a bicuspid belongs, hold the tooth horizontally with the buccal surface, which may be known by its greater breadth, upward, and looking at the grinding surface, the higher proximo-grinding ridge and the closer proximity of the cusps, especially the lingual cusp, will indicate the side to which it belongs.

Superior Molars (Fig. 1, F, G. p. 22).—These have large, square-shaped crowns specially adapted for crushing and grinding. The following description will apply to the first and second molars, but while the first is quite constant in form, the second is more variable.

The grinding surface has a rhombic outline with rounded

angles. The mesio-buccal and disto-palatal angles are acute and the mesio-palatal and disto-buccal obtuse. On the surface are four cusps, one at each angle, the mesio-palatal being considerably the largest, the mesio-buccal next in size and the linguo-distal the smallest. The linguo-mesial cusp is connected with the disto-buccal by a thick, oblique ridge, and between this ridge and the mesio-buccal cusp is a deep depression, from which a fissure extends toward and often through the buccal border. Another extends toward the mesial border and a third runs into the oblique ridge. Between the middle portion of the oblique ridge and the linguo-distal cusp is another deep depression, with a fissure extending frequently through the lingual border, while the other extremity of the fissure rarely extends far enough to divide the distal border. The linguo-distal cusp thus separated is to be regarded as the cingule, the other three being true cusps.

The buccal surface is divided nearly in the middle by a perpendicular groove which is continuous with that on the grinding surface. The mesial portion of this surface is much more prominent than the distal, which slopes backward. The lingual surface is similarly divided, the distal portion being the more prominent.

The proximal surfaces are broad and convex, becoming flat at the cervical portion.

A section at the neck shows an outline similar to that of the grinding surface, four-sided with unequal angles.

The root is divided into three, one large and nearly conical, diverging inward, and called the palatal root, and two buccal, the mesio-buccal much larger than the distal, and both much flattened mesio-distally.

Frequently the disto-buccal and palatal roots are united throughout their whole extent.

The superior third molar sometimes conforms to the description above given, but usually the crown is smaller and of very irregular form, and the roots united into one throughout the whole or greater part of their extent.

If the student hold an upper molar with the crown downward and the two buccal roots next to himself, the larger and broader root will be toward the side to which the tooth belongs.

Teeth of the Lower Jaw.—The *inferior central incisor* (Fig. 1, I, p. 22) is the smallest tooth in either denture.

The *lateral incisor* (Fig. 1, J, p. 22) is a little wider and the root considerably longer. The width of these two teeth is about three-fourths as great as that of the two corresponding superior incisors.

The cutting edge of an inferior incisor is straight and nearly at right angles to the long axis of the tooth, though the distal angle is usually a little lower than the mesial.

The labial surface is widest at the cutting edge and narrowest at the neck, the proximal borders converging equally from the cutting edge downward. The enamel border at the neck is not prominent, and the surface is but slightly convex from above downward.

The lingual surface is flat from side to side at its upper part, and rounded below and slightly concave from above downward. The cingule is not developed.

The proximal surfaces are nearly equal, flat and triangular, with the cervical border of enamel quite thin.

A cross-section at the neck is elliptical and quite narrow mesio-distally, and the root much flattened in the same direction.

The Lower Cuspid (Fig. 1, K, p. 22).—This tooth, compared with the upper cuspid, is smaller and less specialized in form, resembling somewhat the conical teeth of the lower orders of animals. The crown is narrower and more elongated than that of the upper tooth.

The labial surface is rounded and rather more prominent near the mesial border than elsewhere, and quite strongly convex from above downward.

The lingual surface is flat or slightly concave, and the proximal surfaces triangular, the mesial somewhat the larger.

A transverse section of the neck is oval in form, with the labial portion wider.

Inferior Bicuspids (Fig. 1, L, M, p. 22).—The first bicuspid is smaller than the second, the buccal cusp is prominent and the lingual small and often very short. The two cusps are united by a stout ridge of enamel passing across with a pit at each side.

The buccal surface is prominent below and slopes rapidly away toward the grinding surface. From side to side it is moderately convex.

The lingual surface is more prominent at its upper portion, making the tooth appear bent inward at the neck.

The proximal surfaces are smoothly convex from side to side and most prominent near the upper border.

A transverse section at the neck is nearly circular, the root nearly round and often but slightly tapering.

The inferior second bicuspid corresponds to the description just given, except that the crown is larger and the lingual cusp more fully developed, with a tendency to the formation of two lingual cusps. A like ridge connects the two cusps and all the surfaces are similar, though the lingual surface is larger.

The inferior first molar (Fig. 1, N, p. 22) is usually the largest tooth of the lower jaw. The broad, grinding surface supports five cusps, three buccal and two lingual, or they may be described as two buccal, two lingual and one distal. The mesio-buccal cusp is the largest and the disto-buccal the smallest, the other three are subequal.

A fissure extends across this surface from a point near the mesial border to the disto-buccal cusp, and from this point two fissures run, one between the middle buccal and the disto-buccal cusp, the other between the disto-buccal and disto-lingual cusps. A fissure running from the one first mentioned passes nearly to the lingual border dividing the two lingual cusps, and another passes toward and often through the buccal border behind the mesio-buccal cusp.

The buccal surface is broad and much rounded off at its

upper portion. Across this surface from above downward passes a groove, near the middle of which a pit is often found.

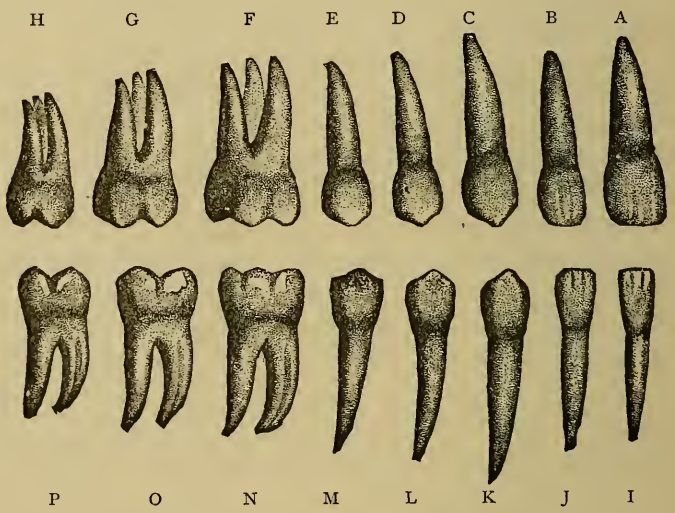
The lingual surface is more prominent near the grinding surface and usually smooth.

The proximal surfaces are broad and rounded above and flattened below.

The transverse section at the neck is nearly square with rounded angles.

There are two roots, a mesial and a distal; the latter being

Fig. 1.



subcylindrical, while the mesial is very much flattened and grooved, and both are usually curved backward.

Inferior Second Molar (Fig. 1, O, p. 22).—This has a grinding surface which is very nearly square, with four cusps nearly equal in size. The groove which separates the mesial and distal cusps sometimes passes through the border to the buccal surface, but this is less frequent than in the first molar. Occasionally the second molar has five cusps, the conformation of the crown being similar to that of the first molar. The buccal

surface recedes toward the grinding surface, but not to an equal extent with that of the first molar.

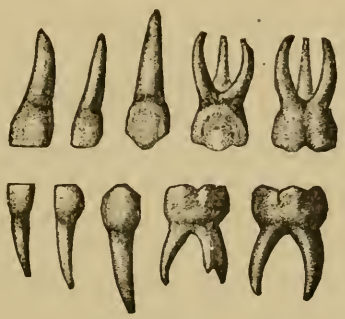
The lingual rises abruptly to its angle with the grinding surface.

For the proximal surfaces and roots the description given for the first molar will apply to this tooth.

Inferior Third Molar (Fig. 1, P, p. 22).—This varies very much in regard to its size and form, but usually the crown is large in comparison with the root, and frequently, also, in comparison with the crowns of the first and second molars.

The grinding surface is generally of an irregular outline, having from three to five cusps. All the other surfaces are

FIG. 2.



rounded and receding toward the neck, the outline of which, in transverse section, is more nearly circular than that of the two preceding teeth. The root is usually single, grooved on each side, short and curved backward, often to a considerable extent.

The Deciduous Teeth (Fig. 2).—In general terms, these teeth have the same forms and characteristics as the corresponding teeth of the permanent set.

The six anterior teeth of each jaw are succeeded by those of the same classes as themselves, while the deciduous molars are the prototypes, not of the bicuspids which succeed them, but of the permanent molars.

The deciduous teeth are, in all respects, smaller than the per-

manent, the crowns are thick and short, and the roots of the molars are much flattened and strongly divergent.

The enamel of these teeth terminates abruptly, which gives the effect of a strongly-marked constriction at the neck. So constant is this characteristic that retained deciduous teeth may always be recognized by passing an instrument under the free margin of the gum.

In structure they are ordinarily less firm and dense than the permanent, and the pulp cavity is larger in proportion to the size of the tooth.

In their position and arrangement there is seldom any irregularity, the arches being even and rounded.

DENTAL CARIES.

Dental caries was formerly supposed to be identical with caries of bone, hence the use of the term. This name is now in almost universal use. It has a recognized signification and cannot well be changed, especially as our present knowledge of the pathology and causation of the disease cannot furnish an expressive and significant name.

Decay is another term in common use to express the same condition.

The disease involves the hard tissues of the teeth and results in the destruction of a part or the whole of the organ attacked.

In every country of the world and in all ages the human teeth have been thus destroyed, and to the prevalence of this disease alone operative dentistry owes its rise and progress, and at the present time, while other diseases of the teeth and contiguous parts require attention, dental caries claims a much larger share of the skill and labor of the dentist than all other affections of the dental apparatus.

Clinical History.—As, in a perfectly normal condition, enamel is the only tissue exposed to external influences, this must necessarily be first destroyed and removed at some point before the dentine is reached by the destructive agencies, which are always external. If, however, a portion of the dentine is

exposed, as a result of imperfect calcification, fracture or wear, caries may have its beginning in this tissue, and, in cases of recession of the gum exposing the cementum, this may be first attacked.

For convenience of study the progress of caries is divided into three stages, superficial, simple and complicated. Superficial caries affects only the enamel. Simple caries may advance to any depth and extent consistent with the health and safety of the pulp, while complicated caries implies a diseased condition of the pulp as a result of the carious process.

Incipient caries of the enamel is marked by an opaque, whitish spot, which to the touch of an instrument will be found soft and friable. This soon becomes discolored by the deposit of extraneous coloring matter, and if, as is sometimes the case, a change in the conditions or surroundings of the tooth should cause the decay to be spontaneously arrested, the enamel, and if the decay has penetrated the dentine, this also, will usually become very dark or almost black.

Some believe that the color of the disintegrating tissue depends mostly or wholly upon the kind of acid which has acted upon it. Three kinds of caries are described; first, black, caused by sulphuric acid. This is not as frequent as the other varieties. Its progress is very slow in all cases, the blackened tissue remaining quite hard, and often it is spontaneously arrested.

Second, brown decay, the result of the action of hydrochloric acid, which destroys the lime salts of the tooth, leaving the organic portion of a brown color, and elastic, leathery consistence. This progresses more rapidly than the preceding, and it is seldom arrested spontaneously.

Third, white decay, produced by nitric acid, which rapidly destroys both the mineral and the organic constituents of the tooth so that they are readily washed away, the cavity being usually filled with extraneous matter.

Recent researches by Dr. Miller seem to show lactic acid to be the principal agent in the production of caries.

In practice, tissue that has been partially or wholly decalcified will be found of all possible variations of color and consistency; these variations being the effect of the combined action of the destructive agencies, or of other conditions, as length of time, quality of the tooth-substance, condition of the mouth or habits of the individual.

As caries progresses, the cavity assumes one of two general forms, becoming either broad and shallow, with no well-defined walls or orifice, or else narrow and penetrating, enlarging within the dentine and extending toward the pulp, while the opening in the enamel remains comparatively small.

Certain surfaces of the teeth are specially liable to be attacked by caries, this liability, in each case, depending mostly upon the form of the tooth and its relation to other teeth.

Of the incisors and cuspids the proximal surfaces are the most frequently affected, and next the labial surface at the margin of the gum. If a pit exists on the palatal surface, this is frequently the seat of caries.

The bicuspids are also most frequently attacked on the proximal surfaces; secondly, in the pits or fissures on the grinding surface; and, thirdly, the buccal surfaces at the margin of the gum.

The molars decay most frequently in the fissures of the grinding surface; secondly, on the proximal surfaces; and thirdly, on the buccal, in the pit upon this surface, or at the gum margin, and lastly on the lingual surfaces.

Decay upon any point of the surface of a tooth may result from defective structure, or from special causes.

The tooth most subject to decay is the lower first molar of either side, and next to this the upper first molar. The lower incisors and cuspids are the least liable to decay.

Present knowledge of the subject does not warrant any definite statement respecting the relative liability to decay of the other teeth.

Causation.—The predisposing causes are both general and local. The former have reference mainly to systemic condi-

tions, as impaired health from any cause, especially affections of the nervous and digestive systems, and the state of the bodily functions at different periods of life.

Local causes have reference to organization, calcification and environment of the teeth, these depending largely upon the food, occupation and habits of life of the individual.

Acids undoubtedly act as the primary exciting cause of decay of the teeth, though many other factors are concerned, especially microörganisms and inflammation, or a process closely allied to this. For the discussion of the "theories of decay" the student is referred to larger treatises and the periodical literature of the subject.

WORKING STEEL.

Very often an instrument of peculiar form is needed for a special case; it is therefore very important that every operator should be able to make such instruments as necessity requires, and the following directions will enable him to do so.

A worn excavator is the ever-ready material for this purpose. Heat to a cherry red, and hammer it upon the anvil toward the form desired only as long as it will readily yield. Repeat the heating and hammering until the desired form is obtained. Heating hotter than a cherry red or hammering when too cool injures the steel. Bend the point to the form desired and reduce to proper size; form the edge by filing and grinding. Smooth and polish with emery, stone, pumice and rouge; the instrument is then ready for the process of hardening and tempering.

To obtain the proper temper for a good cutting edge, the instrument must first be heated to a bright red heat and suddenly cooled by plunging into cold water or other cold liquid. This will give to the steel a silvery whiteness, and render it so hard that a sharp corner will readily scratch glass; this should be the test of the hardening. Make the part to be tempered clean and bright with fine emery or by other means; heat the instrument slowly well up on the shank, and allow the heat gradually to approach the point; the blue and straw colors will

be seen to run down on the shank as the heat progresses. There will be all the shades of blue from very dark to very light, and joined to this a dark straw color which will terminate in a very light straw.

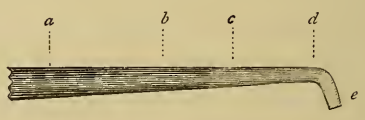
The dark blue represents a soft steel, the medium and light blue a spring temper; the dark straw shows a soft cutting edge and the pale straw a very hard cutting edge.

When the instrument is tempered, the position of the colors should be as marked in Fig. 3.

A thick edge will bear a much harder temper without breaking than a thin edge, consequently the thick edge may be left a very pale straw, while the thin edge must be a little darker.

For drawing the temper of small instruments, the flame of

Fig. 3.



a, Point where heat is applied.
b, Dark blue.
c, Light blue.
d, Dark straw.
e, Light straw.

the annealing lamp is sufficient. For hardening, a greater heat is required.

The shank of the instrument should be of spring temper, and some practice will be necessary to obtain a good spring temper throughout the length of the shank and avoid reducing it too low in some places.

A weak solution of sulphuric acid will in a few moments remove from the instrument all of the coloring caused by tempering.

Sharpening Instruments.—The rough grinding may be done with a fine corundum wheel well moistened, to avoid heating the instrument, after which an Arkansas oil stone should be used for giving a fine edge.

"**Instructions for Making Instruments from Piano-Wire for the Removal of the Contents of Pulp-Canals.**—The very best quality of piano-wire, of No. 20 or No. 22 standard wire or plate gauge, should be used.

"It should be cut into lengths of three inches, and should then be filed down to the required size and taper. The wire should commence to taper at one and one-half inches from the point, while the last half inch should be of nearly uniform size.

"Three sizes of these instruments are all that are needed, and they should measure, at the smallest diameter, 0.007, 0.010, and 0.013 of an inch, respectively, before the hook is made; with the hook they should measure 0.010, 0.014, and 0.017 of an inch.

"When the wire is reduced to the required size, the hook is to be formed by placing the wire on an anvil, or other smooth hard surface, and holding the smooth edge of a thin knife blade upon it, near the end of the wire, when the wire is to be drawn up sharply and tightly, making a hook with a somewhat acute angle. The hook can then be honed down to the desired length.

"The instruments should then be fastened in small handles, which can be procured of dealers in watchmakers' supplies for twenty-five cents a dozen, or they can be easily made from any soft or hard wood.

"Piano-wire should never be heated, and should be filed lengthwise."

"**Method of Rendering Swiss Broaches of Spring Temper.**—To draw Swiss broaches to a spring temper they should be placed on a steel, iron, or brass plate, one-eighth of an inch in thickness and three inches square. This should be held by pliers or forceps over the flame of a spirit lamp, and be kept continually moving over it, so as to keep the plate as uniformly heated as possible. The broaches should be watched very carefully, and when they become of a dark-blue color they should be dropped in cold water."

"**Method of Rendering Swiss Broaches Completely Soft.**—A piece of tin may be cut and bent so as to make a rough

box, two and one-half inches long by one inch square. This should be filled half full of slaked lime, and the broaches—one, two, or three dozen—placed in the middle of the lime, and the box then filled over them. This should then be heated to a red heat, either with the blowpipe or in a stove fire, and then allowed to gradually cool. They can then be polished by holding them flat on a hard smooth surface and rubbing them lengthwise with oo emery paper.

"Broaches rendered soft in this manner are very tough and can hardly be broken, and are safer for use in places difficult of access than those of spring temper.

"They should be fastened in small handles, or used in the universal broach holder."*

INSTRUMENTS.

The number and variety of dental instruments now manufactured is so great that it would be impossible to describe or name them in this work, and a description of important classes only will be attempted.

FIG. 4.

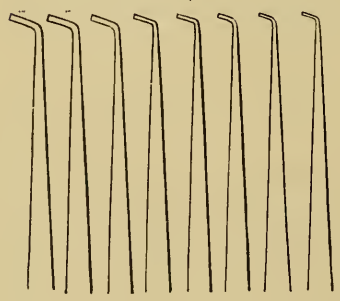
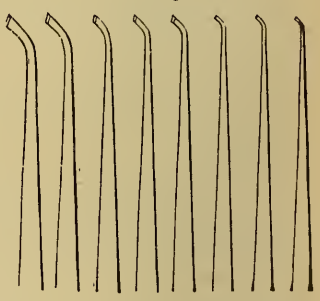


FIG. 5.



Excavators are made in great variety of form, the principal of which are hatchets, hoes and spoons.

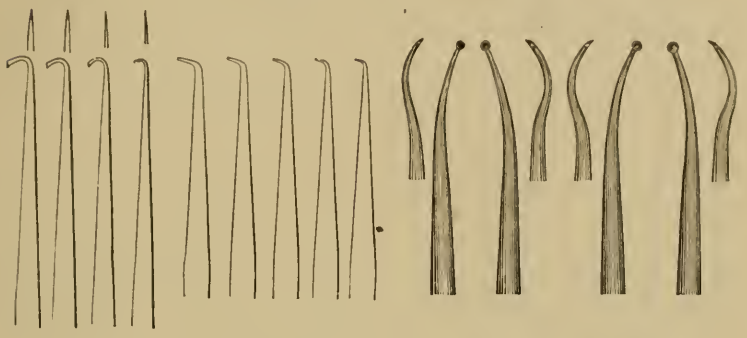
We have the following in various sizes:—

The right-angle hatchet (Fig. 4), the obtuse-angle hatchet (Fig. 5), the acute-angle hatchet (Fig. 6), hoes of the various

* "Management of Pulpless Teeth." Chicago, 1887.

sizes (Fig. 7), spoons (Fig. 8). Fig. 9 shows a style of excavator in which the cutting edge is brought on a line with the handle, thus working with much greater ease and steadiness than the ordinary style.

Fig. 6. Fig. 7. Fig. 8.



All these instruments are also made with two angles in the shank. (Fig. 10.) They are also made in pairs, curved to cut right and left.

Fig. 9.

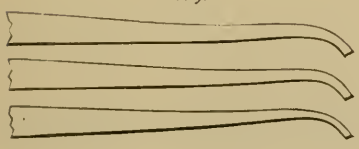
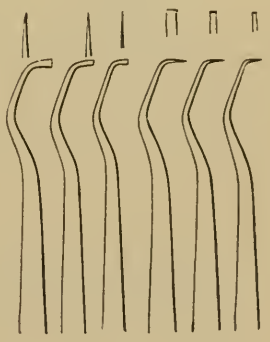


Fig. 10.

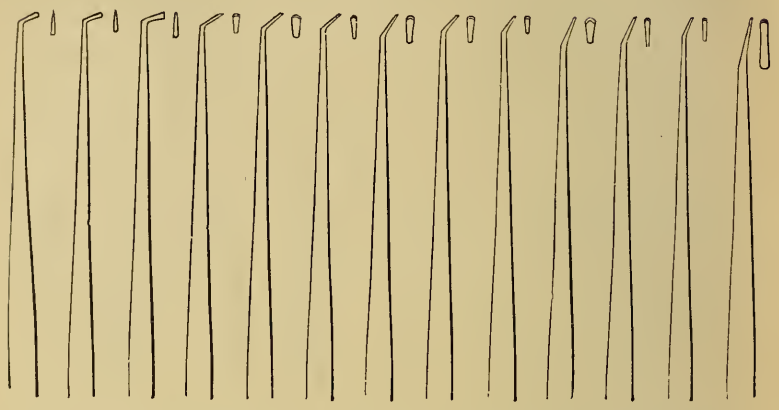


Chisels of various sizes and forms are useful in breaking down the edges of cavities, dressing down the exposed edges of enamel and removing decayed dentine.

A class of these instruments, known as Head's Excavators

—shown in Fig. 11—gives a variety of forms which enables the operator to cut in every direction.

Fig. 11.



Another class are known as hard bits, the cutting edges of which are right angles, and the temper very hard. They are very effective in dressing away enamel, as they cut smoothly and evenly without chipping. They are shown in Fig. 12.

Fig. 12.

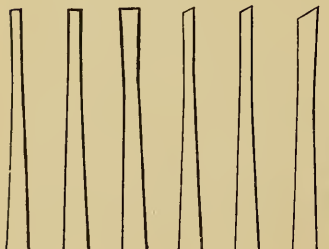


Fig. 13.

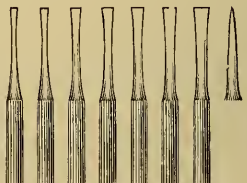


Fig. 14.

Each has eight cutting edges, and each edge will cut in two directions.

Two forms of drills are illustrated: the flat, square-pointed and the spear-pointed.

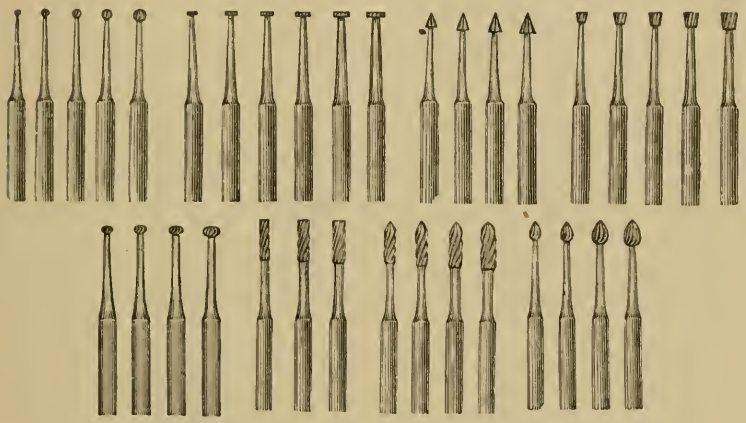
The flat, square-pointed are especially useful for drilling retaining pits (Fig. 13). The spear-pointed (Fig. 14) are

adapted for drilling enamel and dentine, to reach the pulp chamber, and for other purposes.

These are made in various sizes—some quite small, and with long, spring-tempered shanks, which allow them to be used in canals inaccessible to straight instruments that are not flexible.

Burs are made in great variety of forms and sizes, as shown in Fig. 15. They are known as round, wheel, cone, inverted cone, bud, fissure and oval. These are made both for use as hand instruments and for the engine.

Fig. 15.



Instruments for Pulp Canals.—These consist of broaches, drills, reamers and pluggers. Broaches for removal of the

Fig. 16.

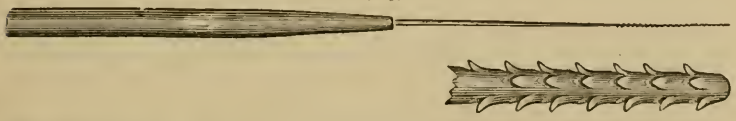
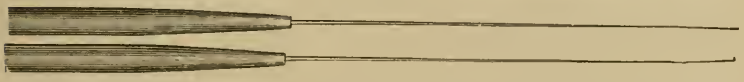


Fig. 17.



pulp are of various forms, as the barbed broach (Fig. 16), the fine, spring-tempered hook broach (Fig. 17).

Fine hook broaches are also made of fine piano-wire, by filing down without changing the temper. Broaches are also made of an alloy of platinum and iridium, which are useful for medication, as they do not corrode.

Drills for use in the pulp canals should be of small size and flexible. The points may be square, spear-pointed, or enlarged in the form of a bud and with sharp edges for cutting, as shown in Fig. 18.

Reamers for nerve canals are made pointed and in the form of a square, triangle, or half cone (Fig. 19).

FIG. 18.

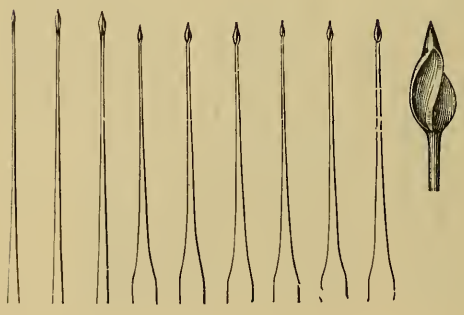


FIG. 19.

FIG. 20.

The smaller instruments should have flexible shanks. Those made from piano-wire are excellent.

Pluggers for pulp canals should be of long taper, spring-tempered and small enough to reach the deepest portion of the canal. Both straight and curved are needed (Fig. 20).

Instruments for Cleaning Teeth.—Instruments for the removal of calcareous deposits from the teeth are called scalers. They are of various forms, which may be best understood by reference to the following cuts :—

The essential part of the instrument is a sharp edge for scraping the deposit from the teeth.

Fig. 21 illustrates the Abbott set of scalers.

Fig. 22 shows the Cushing scalers, which are formed for removing the deposit by pushing.

Fig. 21.

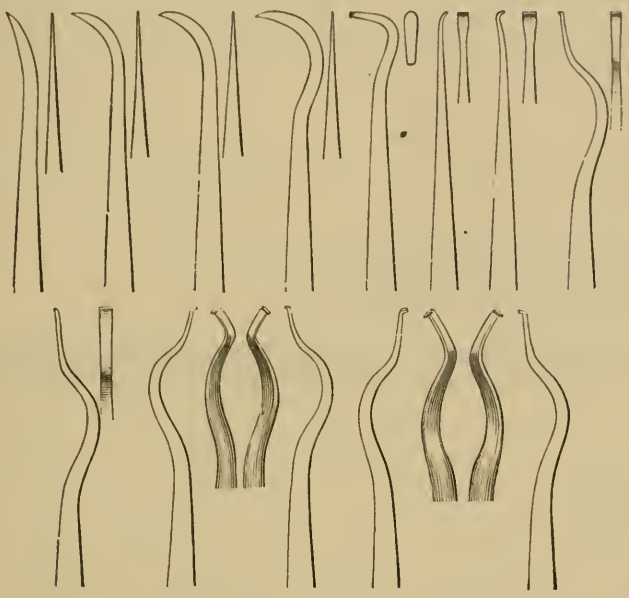


Fig. 22.

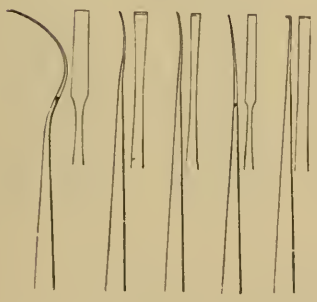
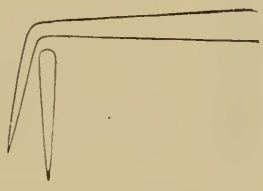


Fig. 23.



The right-angle edge, which is found on the hard bit and on the sickle-shaped scalers of several sets, is effective for this purpose.

Fig. 23 represents a modification of one of Riggs' instru-

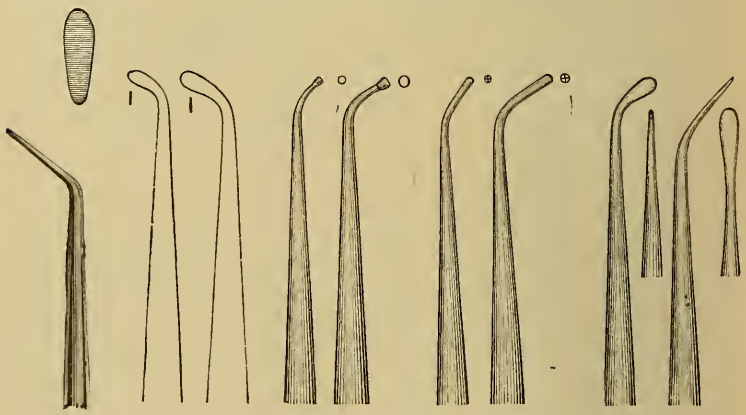
ments. It should be made very hard, with square, sharp edges, like the hard bits. It is a universal instrument, cutting in all directions.

Instruments for Filling.—Instruments for filling are made in such variety of form and style that it would be quite impossible to describe them all. The essentials which all should possess are described, leaving the choice of form and style of instrument to the operator.

Instruments for filling with cements consist of a flexible spatula for mixing (Fig. 24), thin, flat instruments for inserting the filling (Fig. 25), and some broader and smooth, as well as thin, for finishing (Fig. 26).

FIG. 24.

FIG. 25. FIG. 26. FIG. 27. FIG. 28. FIG. 29.



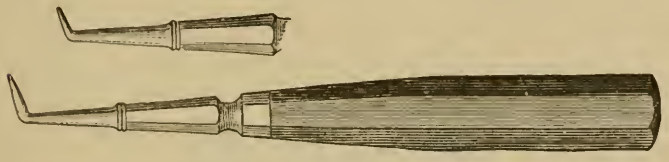
Ball burnishers are sometimes useful for packing the cement and for finishing.

For packing amalgam, instruments of various forms and sizes, with smooth or serrated oval surfaces, are best adapted (Figs. 27, 28).

Flat burnishers of different sizes, some thin, some bent on the edge and some on the flat (Fig. 29), are also useful. These two classes of instruments will be sufficient for all cases.

Pluggers for Gold.—For packing non-cohesive gold, instruments acting upon the wedge principle are used. The points are long and tapering in form, terminating in a wedge-shaped edge (Fig. 30).

Fig. 30.



These are used entirely with hand pressure.

In finally condensing the surface of the filling, a larger instrument is used, with a broad, flat surface.

For packing cohesive gold foil, pluggers having either flat or oval surfaces are used.

These instruments are made in great variety to meet the requirements of cavities of all sizes and in all positions. The faces are serrated to prevent slipping and to keep the surface of the gold a little roughened. Two grades of serrations are used, the very fine and the medium. The coarse serrations formerly used have been discarded. These instruments are made suitable to be used either with hand pressure or the hand mallet, and also with the automatic and electric mallet. The following figures illustrate a variety of forms in common use:—

Fig. 31.

Fig 32.

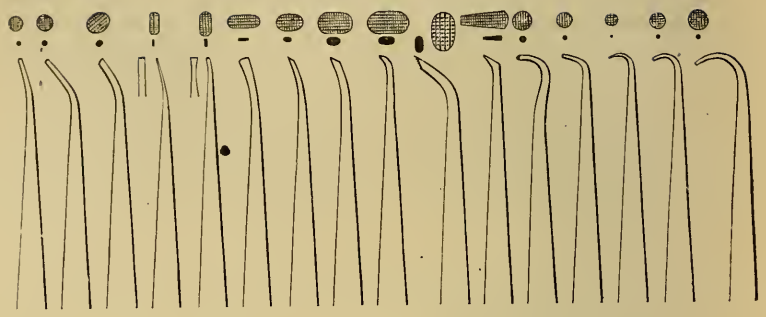
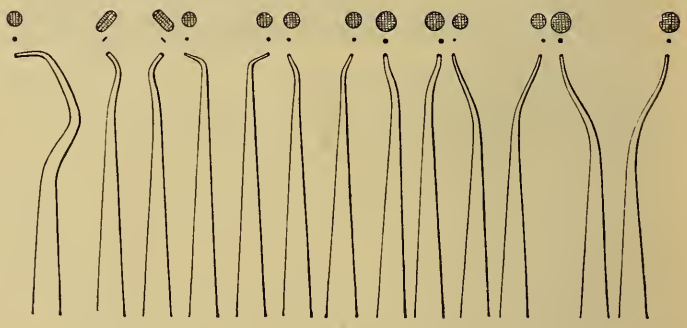


Fig. 33.



Clamps are an important auxiliary in the use of the rubber dam. They serve to hold the rubber upon teeth which have very short crowns or which are far back in the mouth, so that the strain of the cheek or tongue is likely to draw it off, or in any situation in which it is impracticable or undesirable to apply the ligature. They also serve to hold the rubber away, and thus afford a better view of the tooth operated upon.

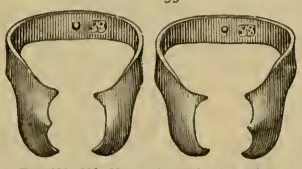
Very many different forms have been devised for the different classes of teeth and of cavities, and the student must select such as will best serve his purpose.

The following figures show several sets of the more desirable forms :—

Fig. 34.

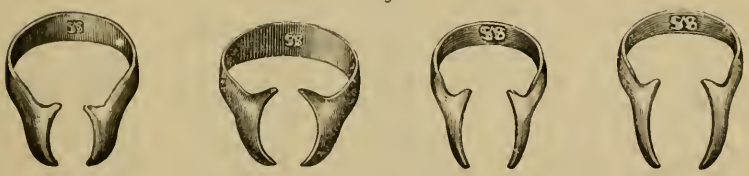
Fig. 34 represents How's cervix clamp. Its purpose, construction and adjustment are plainly shown in the cuts.

Fig. 35.



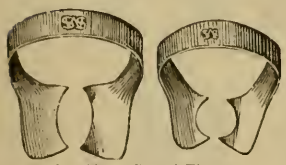
Dr. W. W. Evans' Beaked Molar.

Fig. 36.



Dr. E. C. Moore's.

Fig. 37.

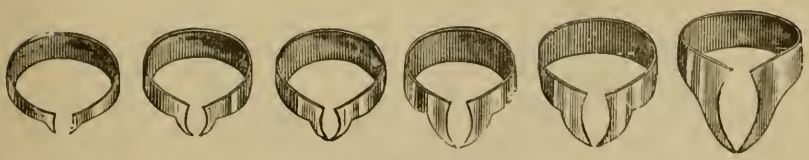


Dr. Tees' Broad Flange.

Fig. 38.

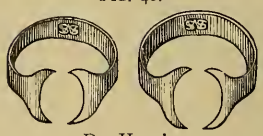
Dr. Tees' Festooned.

Fig. 39.



Original Allan—Plain.

FIG. 40.



Dr. Huey's.

FIG. 41.

Dr. Delos Palmer's Set.

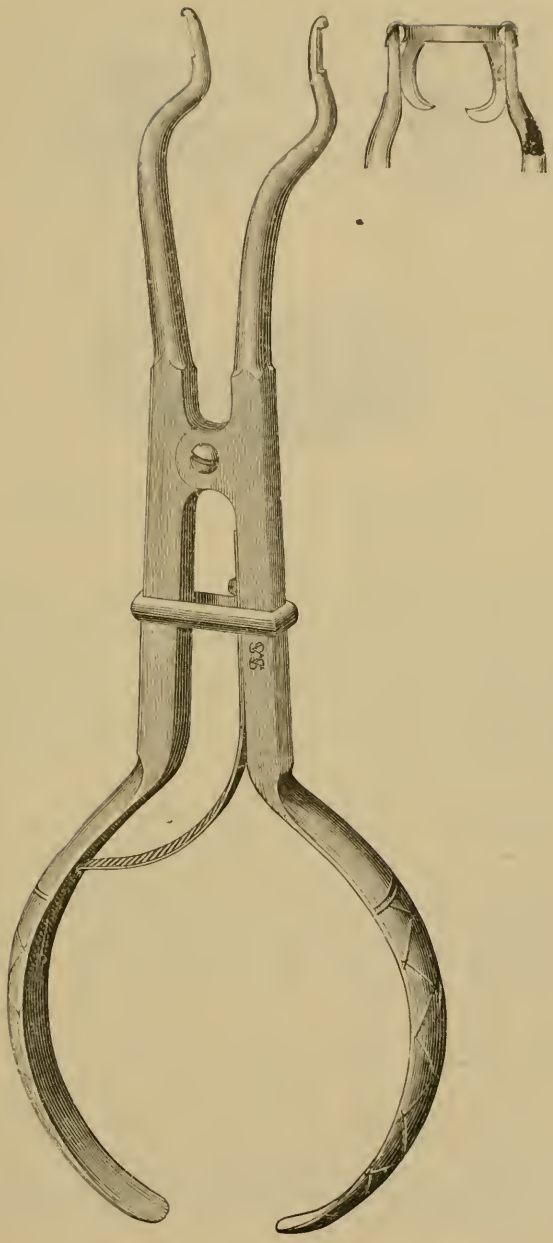


FIG. 42.

Fig. 43.

Fig. 44.

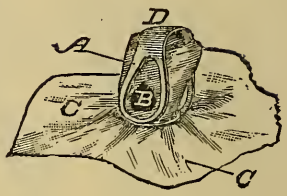
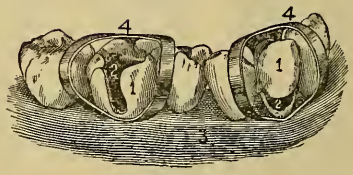


Fig. 45.



1. Inferior six-year molar and canine. 2. Cavities of decay. 3. The rubber dam applied. 4. The clamps holding the dam in place, making visible and keeping dry the cavities while impacting the gold.

Figs. 43, 44, 45 show Dr. D. B. Freeman's cervix clamp.

Fig. 42 shows the Brewer universal forceps, which is adapted to all clamps, with few exceptions.

Other forceps may be obtained for clamps of special form.

Burnishers for use upon gold fillings are sufficiently described by the illustrations.

Fig. 46.

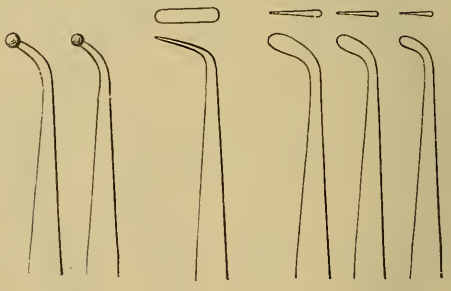


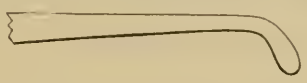
Fig. 46 represents three of the most important general forms.

Finishing instruments consist of files and burnishers. Fig. 47 shows Smith's proximal trimmers. Numerous appliances, in addition to these, are used, which are mentioned under accessories.

In some cases the thin, flat, separating file is useful. A

Fig. 47.

Fig. 48.



thin instrument, with a sharp knife edge (Fig. 48), is useful to dress away the overhanging gold at the cervical wall. A chisel or hard bit is also often effective.

Finishing burs, corundum points, wood, leather and rubber points and disks are used almost exclusively with the engine.

Fig. 49.

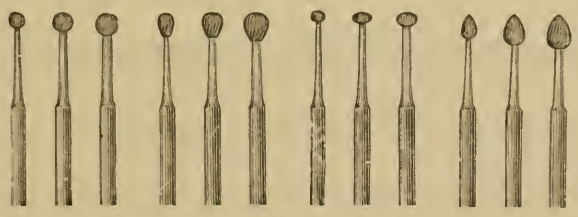


Fig. 49 shows a few sizes of the more important forms of finishing burs.

The Dental Engine.—The dental engine has become an almost indispensable aid to most operators. The essential parts of the engine are the hand-piece and the arm, the latter

either flexible or jointed, making it possible to use a bur or drill in any direction.

The S. S. White engine has the flexible arm, and the Bonwill and the Shaw engines have the jointed arm, the last having a flexible portion next the hand-piece. This arm is attached by suitable mechanism to a foot-power or to a water or electric motor.

The Morrison suspension engine is also in use. The power for operating this is transmitted by a long belt over pulleys to

FIG. 50.

the engine, which is suspended over the operating chair. When used, the hand-piece is drawn down to the mouth of the patient, and when not in use it is raised by weights or springs, so arranged as to hold it suspended.

There are two forms of hand-piece. One is the universal chuck, which will carry any instrument of the size ordinarily used for the engine. For the other form of hand-piece, instruments must be especially fitted.

Improvements and changes are being constantly made in

FIG. 51.

FIG. 52.

engines and hand-pieces, and it is impracticable to describe or mention them all.

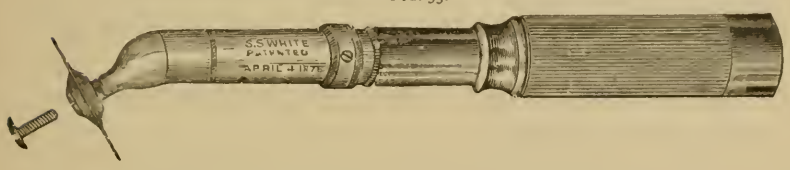
In addition to the instruments already described for use with the dental engine, Dr. Robert Huey's screw-headed mandrel (Fig. 50) is useful for carrying disks of rubber, corundum, or sand paper, and also Klump's screw-clamp porte polisher (Fig. 51) for carrying points of wood or corundum for grinding or polishing.

Fig. 52 shows a mandrel useful for leather disks.

The right-angle and acute-angle attachments render the bur or drill applicable in many places inaccessible to the straight hand-piece.

The disk carrier (Fig. 53) is also a valuable attachment, the fixed angle of the instrument giving different directions to the disk as the hand-piece is turned, thus making the disk appli-

Fig. 53.

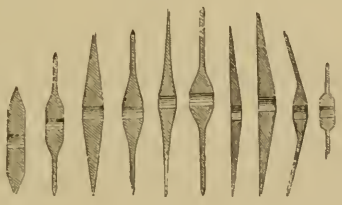


cable in many places which could not be reached by the straight mandrel.

The general forms of disks are shown in Fig. 54.

Small wheels for the engine are now made of corundum specially prepared and baked in a furnace at a very high temperature. They are so hard as not to be perceptibly worn in grinding the teeth, and they are not affected by any heat

Fig. 54.



arising from friction. Small stones for the engine are also made of the same material.

Disks of hard and of soft rubber are also used for carrying powder for polishing the natural teeth and for finishing fillings.

Points of corundum, stone, wood, rubber and leather are made in great variety of forms for finishing and polishing.

Many other instruments and appliances are indispensable, and are mentioned in connection with the operations requiring them. As they may be so readily seen at dental depots, any description of them here seems unnecessary.

THE DENTIST HIMSELF.

The appearance of the operator and his treatment of the patient are very important, and largely promote or hinder his success.

Remember that "order is Heaven's first law," and "cleanliness is next to godliness."

Be master of yourself. Control the temper under all circumstances. Be kind and sympathetic but firm and self-respecting, dignified but not distant, and tolerant of human weakness, both mental and physical.

The operating room should be neat, orderly, well-lighted and airy.

The north gives the steadiest and clearest light, the southerly aspect is the most healthful, while the western sky affords the longest day.

When operating by direct sunlight, a white Holland shade will so soften the light as to make it agreeable, and yet it remains effective. If the shade be placed outside the window, it affords circulation of air between it and the window, and thus keeps the heat from the room. A white awning serves the same purpose, but shuts out more light.

The operating case should be conveniently placed and of sufficient size to allow of a convenient arrangement of the instruments, each instrument or class of instruments in its place.

Every instrument should be kept clean, free from rust and well polished.

Observe scrupulous cleanliness about the spittoon. Wash frequently, deodorize and disinfect. A weak solution of sulphate of copper is an inexpensive and effective disinfectant.

Other excellent disinfectants are Platt's chlorides or permanganate of potash.

Give careful attention to personal cleanliness, especially the hands. Wash them frequently, using the best toilet soap. Keep the nails pared short and scraped clean. When a grimy, rough or chapped condition of the hands obtains, give them a thorough washing in soft water with the free use of carbonate of soda; partially dry the hands and apply glycerine and rose-water, rubbing well; then rinse in clear, cold water and wipe dry. This leaves the hands perfectly clean and soft and promotes healing.

MANNER OF HOLDING INSTRUMENTS.

A few general principles which the student should fully comprehend, are concerned in the holding of instruments.

First, the instrument should be grasped firmly, so as to be fully under control.

Second, the hand should have some firm support to render the motions of the instrument accurate and steady. This support is best obtained by resting the thumb or the third or fourth finger upon such teeth or other parts as will best accommodate the operation.

The instrument is held either between the thumb and the first and second fingers, as a pen is held, as in Fig. 55, or grasped in the palm of the hand, as shown in Fig. 56.

When held like a pen, the fingers which hold the instrument should be kept free from the third finger, which forms the support, so that the motion may not be impeded by contact.

The student is advised to practice a wide range of motion, so that he may operate with ease in any part of the mouth.

Fig. 57 shows an effective range of six inches, with the point of the instrument one inch from the second finger.

Fig. 55.

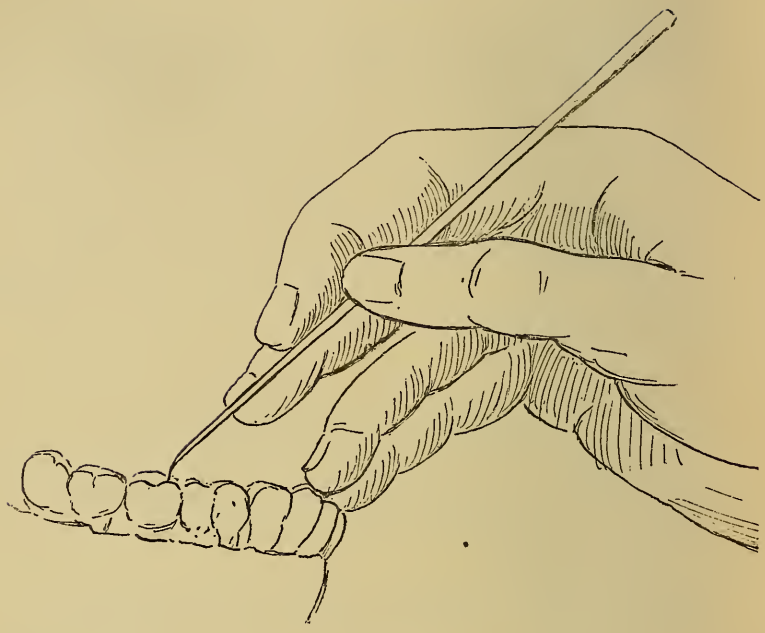


Fig. 56.

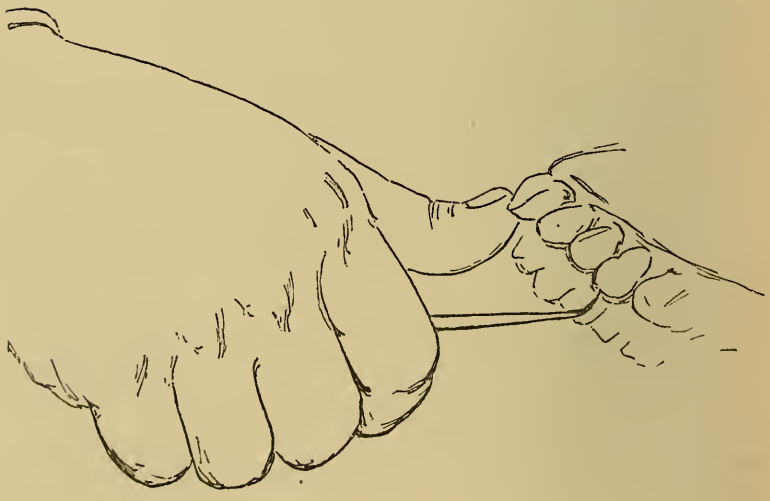


FIG. 57

EXAMINATION OF THE MOUTH.

The instruments required for examination are the mouth mirror and suitable explorers (Fig. 58), and diagram (Fig. 59) for recording.

Fig. 59 is a modification of those proposed by Dr. Perry and Dr. McKellops.

Listen attentively to the patient's story; the history of a case is often important. Respect the patient's fear and dread, and avoid the sudden probing of a sensitive tooth; make haste slowly at first.

Note the age, temperament and condition of the patient. Observe the number, arrangement, form and quality of the

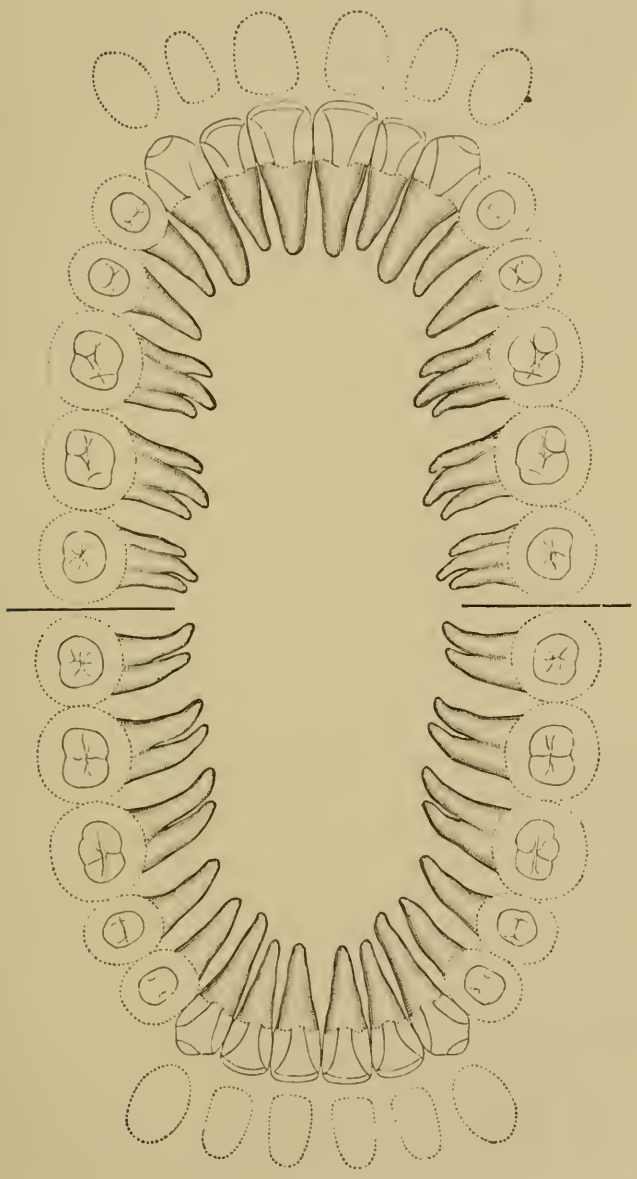
Fig. 58.

teeth, and the general condition of the gums and mucous membrane and the appearance and reaction of the saliva. Notice any existing complication, as local inflammation, ulceration, abscess or tumors. Record all the facts observed briefly, but accurately, for future reference.

Finally, examine the teeth with reference to the location and extent of caries or other defects and operations needed. The results of the examination may be indicated by marks and abbreviations, and such remarks as may be necessary to a complete understanding of the case.

Some system should be adopted in order that the examination may be made complete in the shortest time, and it is

Fig. 59.



recommended to begin with the posterior tooth of the upper jaw on the right side and pass around to the same position on the left side, then commence on the lower jaw and examine the lower teeth from the left around to the right. It will be found best to examine all the surfaces of each tooth before passing to the next.

On all surfaces except the proximal the sight will assist the touch in detecting cavities of decay. For proximal surfaces the pair of instruments above named should be used, passing the instrument between the teeth near the necks and turning the point toward the grinding surface and against the tooth to be examined, where it may be made to enter any cavity upon that surface. For the contiguous surface of the next tooth the other instrument should be used in like manner.

DEPOSITS ON THE TEETH.

Those of importance are salivary calculus, sanguinary or serumal calculus and green stain.

The elements of salivary calculus are present in the saliva of every person. Calculus collects upon the teeth of some in large quantities, while on others it is scarcely perceptible.

It is composed of earthy salts and animal matter. The salts are principally phosphate and carbonate of lime and magnesia. The animal matters consist of fibrine, fat, epithelial scales, food and saliva.

The proportions of constituents vary so that no two analyses give the same result.

Berzelius gives:—

Phosphate of lime and magnesia	79
Salivary mucus and salivine	13.5
Animal matter	7.5
	100.0

The analysis of Vauquelin and Langier gives:—

Phosphate of lime and a little magnesia	66
Carbonate of lime	9
Salivary mucus, including ptyalin	13
Animal matter	5
Water and loss	7
	100

Bacteria, also, are generally present. Calculus varies much in color, being sometimes white or yellowish, at other times of a pale or dark brown color, and in some instances black. The color and hardness have a direct relation to each other; the white is very soft and easily removed, the black is the hardest and adheres to the teeth with great firmness.

Salivary calculus is a deposit from the normal secretions of the mouth, and is in no sense a pathological production; but if allowed to remain on the necks of the teeth it will produce changes of a serious nature in the adjacent tissues.

This deposit collects in the greatest quantities on the lingual surfaces of the inferior incisors and the buccal surfaces of the superior molars, these localities being near the openings of the ducts of the salivary glands. It collects on all the teeth and upon every part of crown and root, even to the apex of the root, and causes neuralgic pain by its constant irritation of the nerves of the pericementum, or by impinging on the nerve of the pulp at the foramen. If not removed it will accumulate in great quantities, sometimes nearly covering the teeth from sight.

Calculus has no effect upon tooth substance, but to the gum with which it is in contact it is very irritating, causing inflammation which extends to the pericementum and implicates the alveolar process, causing its absorption. It produces a morbid condition of the fluids of the mouth and causes fetid breath.

A green or brown stain collects on the labial surfaces of the teeth near the gums, especially on the superior incisors of children and young persons. The surface of the enamel under this is generally found rough and imperfect. The cause and nature of this stain are uncertain, but it is thought by Wedl and others to be a fungous growth, the result of neglect of the teeth.

The hard, dark deposit found upon any portion of the roots of teeth is described as sanguinary or serumal calculus. This is the result of inflammation, and is deposited from the serum

of the blood and colored with the hematin. It contains a larger proportion of mineral matter than any other, and is, consequently, the hardest.

CLEANSING TEETH.

Cleansing teeth consists in the removal of calculus, stains and any other foreign matter from the teeth, leaving the surfaces polished.

Calculus is removed with sharp steel instruments, so formed as to be readily applied to every part of each tooth. In their use care should be taken to avoid scratching the surfaces of the teeth. The square edge of the hard bit is particularly well adapted to this purpose; it is very effective and safe and is utilized in many of the scalers used. The instrument is held firmly against the tooth and carried along parallel with the surface, the edge clearing the calculus before it.

The scalers described in the chapter on instruments will prove excellent in skillful hands.

Dr. Abbott's set is well adapted for general practice, as they are capable of so wide a range of motion and application.

Dr. Cushing's set, especially arranged for the application of the pushing force, is effective.

Dr. Harlan's set is also used with the pushing force, and are effective instruments.

A Riggs scaler with the edges of the hard bit is an admirable instrument, and will be found an effective auxiliary to any set.

To remove calculus from the roots of teeth, pass a thin, hoe-shaped instrument under the gum beyond it, and drawing toward the crown of the tooth bring the deposit with it, or, using instruments constructed for the pushing force, hold the instrument firmly against the root and press toward the apex until the deposit is loosened.

A second or third sitting is advisable, as some particles of calculus are liable to be left, and unless removed at a subse-

quent sitting, will form a nucleus for further deposit. These will be readily detected after the bleeding has ceased and the gum healed. At the subsequent sittings, whenever a red or blue spot or line remains upon the gum, a speck of calculus will be found beneath it.

After the calculus is removed, polish with powdered pumice applied on an orange-wood stick, or wood point, or soft rubber disk in the engine, followed by polishing putty (oxide of tin) or chalk.

To remove the green and other stains from the teeth, apply tincture of iodine freely and then polish as before. The iodine acts upon the stains and they are then easily removed. Nothing will affect the stain of tobacco smoke. It can be removed only by means of instruments and polishing.

After the cleansing, the patient should be advised to use tooth powder with the brush at least once a day, and to use the brush after each meal, brushing not across, but always lengthwise of the teeth from the gums. The brushing after meals may be omitted without serious results if the toothpick is used, but brushing the teeth in the morning and on retiring is essential to the welfare of the organs. The use of the toothpick after a meal is advisable to remove particles of food from between the teeth. Care should be exercised to avoid crowding the pick between the necks of the teeth and thus injuring the gum.

The ubiquitous wooden toothpick is objectionable on account of its great size, which renders it liable to injure the gum, and the liability to break, leaving pieces to irritate the gum.

A quill sharpened and scraped rather thin is undoubtedly the best.

Dental floss silk is useful and effective, but great care is needed not to carry it too far under the gums and injure them. Properly waxed, it is a very convenient article for the purpose.

Mastication has great influence on cleanliness. People often form a habit of chewing on one side of the mouth exclusively, which is quickly shown by the decided uncleanliness of the

neglected side and the nicely polished appearance of the opposite side. They should be advised to correct the habit and use both alike.

SEPARATING TEETH.

Its object is to afford room for examination or operation. This may be accomplished by wedging the teeth apart or by removal of substance. The wedging may be done by wood, tape, raw cotton, silk or linen thread, rubber, wedge forceps or screw separators.

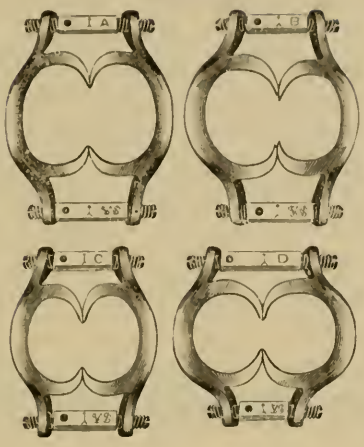
The wood, tape or cotton is used by first inserting a thin portion and exchanging at intervals of twelve or twenty-four hours for thicker, until the desired space is obtained. Cotton is more applicable where a cavity exists. In using thread, tie a knot in it and pass the knot between the teeth and tie the thread around the point of contact, drawing the knot between. This method is suitable only when the teeth are but little decayed. For separating with rubber take fine quality French rubber tubing or the ordinary rubber bands, cut a piece from one-sixteenth to one-fourth of an inch in length, according to force required, slit the tubing, stretch the piece between the teeth and cut off the free ends. The elasticity of the rubber will, in twenty-four hours, separate the teeth sufficiently for ordinary purposes. If the teeth are in very close contact a piece of rubber dam may be first used. Any sharp edges which cut the rubber must be smoothed. Use thin rubber and a narrow piece, to avoid soreness. Maintain the separation with cotton until the tenderness, if there be any, disappears, before operating.

With the screw separators or the wedge forceps the separation may be made in from five to thirty minutes. In using the former, apply and turn the screws until they press firmly, and after waiting a few minutes repeat until sufficient space is obtained. Figs. 60 and 61 show Perry's two-bar separators with wrench for turning bars.

These separators allow the light to be thrown unobstructed

Fig. 60.

Fig. 61.



upon every part of the separated surfaces. Little arrows stamped upon the bars indicate the direction in which they are to be turned to spread the separators. The wrench for operating them is double-end, one end straight and the other bent at an angle to give greater facility for turning the bars in different positions.

Fig. 62.

Fig. 62 shows the separator applied. When there is a tendency, as with teeth of narrow necks, to slip toward the gum, wood or gutta-percha props are to be put on the adjacent teeth, under the bows, to prevent them from tilting, and to keep

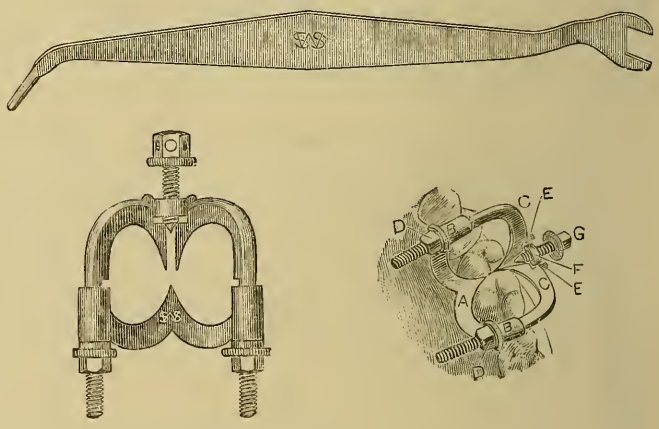
the points from being forced under the gums while the teeth are being separated.

Fig. 63 shows Parr's universal screw separator and wrench. The cut explains the manner of application.

In the use of the wedge forceps the same principle should be observed, of waiting for the teeth to yield to the pressure already applied. In rapid wedging the only space that can be obtained safely is by compressing the pericementum.

For immediate separation with wedges a thin piece of wood or quill is introduced between the teeth, to protect the gum,

Fig. 63.



and next to this a narrow wedge of orange, hickory or box-wood, so formed as not to interfere with the wall of the cavity. These are allowed to remain during the operation, being driven to hold the space gained by a wedge introduced between the points of contact or near the cutting edge, by hand pressure or mallet force, or with wedge forceps. The wedging should be gradual, to allow the tissues to yield to the pressure.

After gaining the space required, the separating wedge should be removed and the projecting portions of the others cut off. If the space should be required for another sitting, remove the wedges and maintain it with cotton and sandarac varnish, or

gutta-percha. Teeth which have been wedged apart soon return to their normal positions when left to themselves.

Separating by cutting away the tooth substance may be done with chisels or "hard bits," and when this is resorted to the teeth should be cut away toward the inside of the mouth, so as not to disfigure the external surfaces. Separation in this manner is applicable to the six anterior teeth of the upper jaw, and is recommended for them only.

It is not necessary nor wise to cut away enough to expose or endanger the dentine. As the normal point of contact near the cutting edge is left undisturbed, the separation is made permanent, leaving a surface which is self cleansing and which causes the filling in proximal cavities to present within

FIG. 64.*

the mouth, subject to examination. (Fig. 64.) This separation is produced by dressing away the proximo-palatal angle of the tooth, but not sufficiently to interfere with the front.

OPENING CAVITIES.

This consists in enlarging the orifice of a cavity of decay so as to render accessible all parts of the cavity. It is done by cutting down the enamel walls, and by removing sound dentine when necessary.

The instruments most suitable for opening crown cavities are chisels, burs and excavators; for buccal cavities, excavators and burs, and for proximal cavities hard bits, chisels and burs.

* The artist has exaggerated this somewhat. It indicates too much cutting away.

In opening proximal cavities in superior incisors and cuspids, cut away the palatal wall till every part of the cavity can be seen by direct sight or in the mirror. A few prefer to cut away the labial portion of the enamel and expose the cavity to direct sight, so that it may be filled from the front and without the aid of a mirror.

Open proximal cavities in inferior incisors and cuspids from the labial surface, but distal cavities in inferior cuspids may sometimes be opened from the lingual surface.

After the teeth are separated proximal cavities in bicuspids and molars should be opened toward the grinding surfaces, except when small and near the gum. In such cases it may be better to open from the buccal surface. If decay is far advanced, the grinding surface should be cut through. When full contour is desired, separate by wedging, open the cavities as in other cases, and restore the contour by filling.

REMOVAL OF DECAYED DENTINE.

This is accomplished by means of excavators, chisels and burs of various forms and sizes, cutting, whenever possible, in a direction from the pulp, as this causes less pain.

In deep cavities, allow a thin layer of decalcified dentine to remain, to protect the pulp, but remove all softened tissue from the borders of cavities, and all discolorations from the enamel or near it, whenever possible, and from any connecting grooves, especially in bicuspids and molars. The deep portions of such cavities should be thoroughly disinfected.

FORMATION OF CAVITIES FOR FILLING.

As a rule, remove all frail and overhanging walls. Sometimes when it is desirable to save them, as in presenting surfaces, they may be strengthened by lining with cement. Remove all unsupported enamel from the cervical wall. This wall should be at right angles to the surface of the tooth.

Make the lateral walls of cavities in incisors and cuspids of such form as they will most conveniently take, and make a well-defined undercut at the cervical wall, and also at the part next the cutting edge, to retain the filling.

The lateral walls of proximal cavities in bicuspids and molars should generally be undercut or grooved, and if the grinding surface is not cut through, this also should be slightly undercut. If this surface is cut through, the grooves of the lateral walls may extend through the opening, thus presenting a dovetailed outline (Fig. 65), or the opening may be left as in Fig. 66. For making these grooves use a small bur, hoe or chisel.

If the cavity is of considerable size, the lateral walls should be cut away, as shown in Fig. 67, so that when filled, the filling

Fig. 65.

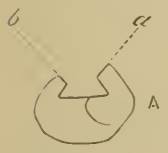


Fig. 66.

Fig. 67.

only will come in contact with the adjoining tooth, leaving the margins free.

Let all angles be rounded and smooth. For filling with cohesive gold, retaining pits are usually made in which to start the filling. Use a small, flat, square-pointed drill, and drill the holes in the dentine near the enamel, and generally parallel with the long axis of the tooth. Avoid drilling toward the pulp. A depth equal to the diameter of the drill is sufficient. Retaining pits are condemned by many as unnecessary and a source of danger to the pulp. In bicuspids one retaining pit is usually sufficient, and is better made at the middle portion of the cervical wall, as the dentine is thickest at this point. These are not needed for non-cohesive gold or for plastic fillings.

In grinding surfaces the walls of the cavity should be nearly parallel, with slight undercuts at opposite points. The same rules apply to the formation of cavities on buccal, palatal or lingual surfaces. For the formation of these cavities various forms and sizes of burs are best suited, but the work may be well done with excavators and chisels.

EXCLUSION OF MOISTURE.

To obtain the best results, the cavity must be kept dry during the operation of filling. For this purpose use napkins, bibulous paper, the saliva-pump or rubber dam. Napkins from three to six inches square, folded into a small compass and held over the openings of the ducts of the salivary glands, and each side of the tooth to be operated upon, will exclude all moisture long enough for an ordinary operation, and if a saliva-pump be also used the cavity may be kept dry for an indefinite time by an occasional change of the napkins. Snow's saliva-pump is effective, but where water pressure can be obtained, the saliva ejector is the most desirable and efficient.

The rubber dam properly adjusted is the most perfect means for the exclusion of moisture. Take a piece of strong rubber dam of medium thickness, about seven inches square, and for application to the upper teeth punch some holes about one and a half inches from the edge and one-eighth to one-fourth of an inch apart, generally on a line parallel with the edge of the rubber.

For lower teeth punch the holes toward the lower part of the rubber, and not less than two inches from either edge.

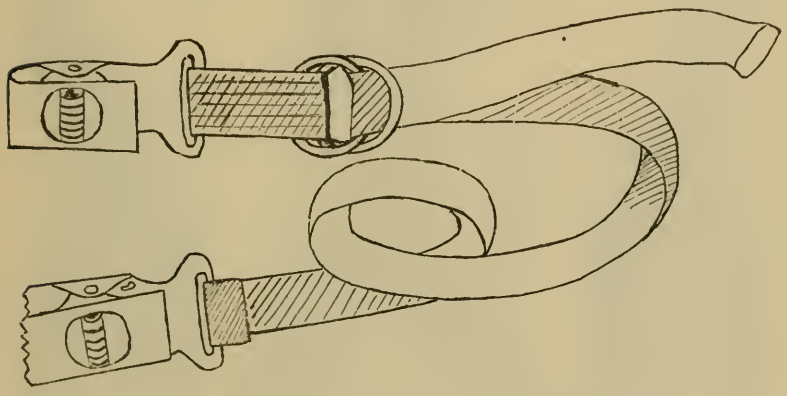
The rubber may be placed upon the face, and the points for the holes indicated by marking over the tooth or teeth when the rubber is carried to place.

The rubber should be supported upon the face with the holder before stretching it over the teeth, as thus the edges are prevented from folding over and interfering with the application of the rubber and the ligature or clamp.

For cavities in the cutting edges or grinding surface frequently only one tooth will need to be exposed, but if proximal fillings are to be made, two teeth at least must be exposed. To support the rubber dam upon the face, use a rubber dam holder—one made from a pair of ordinary sleeve catches connected by elastic braid is convenient and effective. (Fig. 68.) A good form, also, is Cogswell's holder, shown in Fig. 69, also Perry's, Fig. 70.

Before applying the rubber, prove by passing silk between the teeth, that there are no sharp edges to interfere with its

FIG. 68.



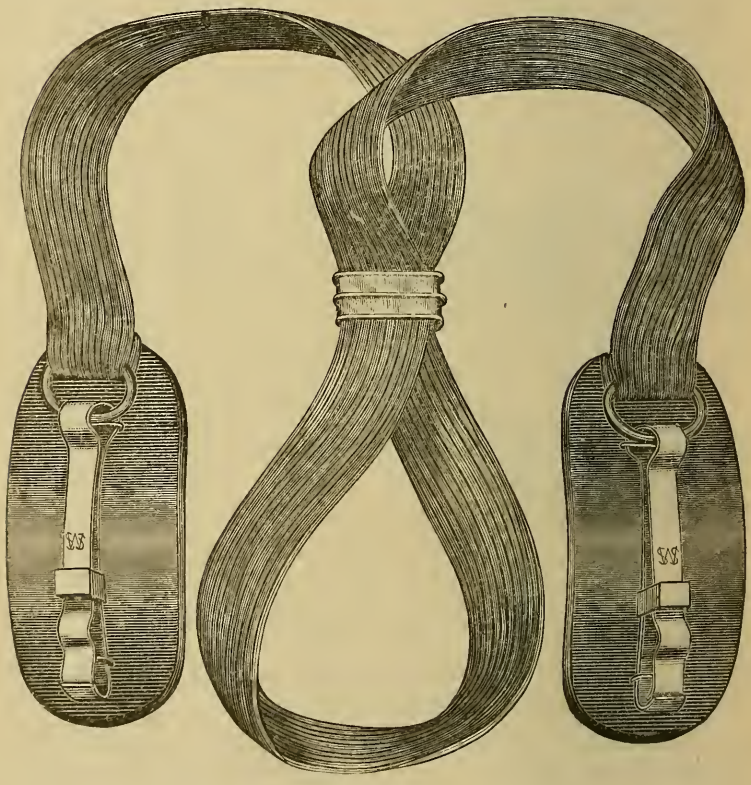
passage. For this purpose and for ligatures, floss silk, not too coarse, well waxed, is best. Binding-wire makes an excellent ligature in many instances, especially when the cavity is at or below the margin of the gum.

Fasten the dam-holder to each upper corner of the rubber, carry the elastic around the head and tighten it, bringing the upper edge of the rubber across the upper lip (Fig. 71), then with the forefinger of each hand stretch the rubber over the teeth. If the teeth are too close together for the rubber to pass easily, apply a little soap, and it may then be readily carried up with the ligature. The ligature should be passed

twice around the tooth and drawn only closely enough to turn the edges of the rubber upward on the neck of the tooth, thus avoiding pain as much as possible, tying firmly with a square or a surgeon's knot.

Should the ligature be impracticable or inconvenient, apply,

Fig. 69.



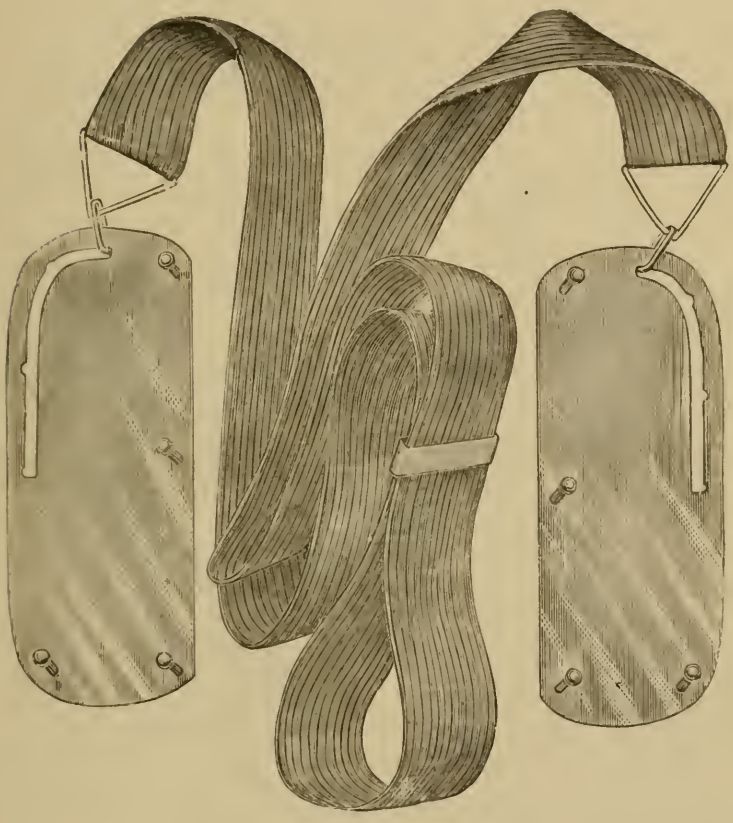
with the clamp forceps, one of the numerous rubber-dam clamps.

To confine the lower portion of the rubber, attach a second dam-holder to the lower corners, allowing the band to pass

around the back of the neck, as in Fig. 72. Weights are also used for this purpose.

Having the rubber dam thus adjusted, place in position the mouth-piece of the saliva-pump, and the work will be kept dry and the patient comfortable.

Fig. 70.

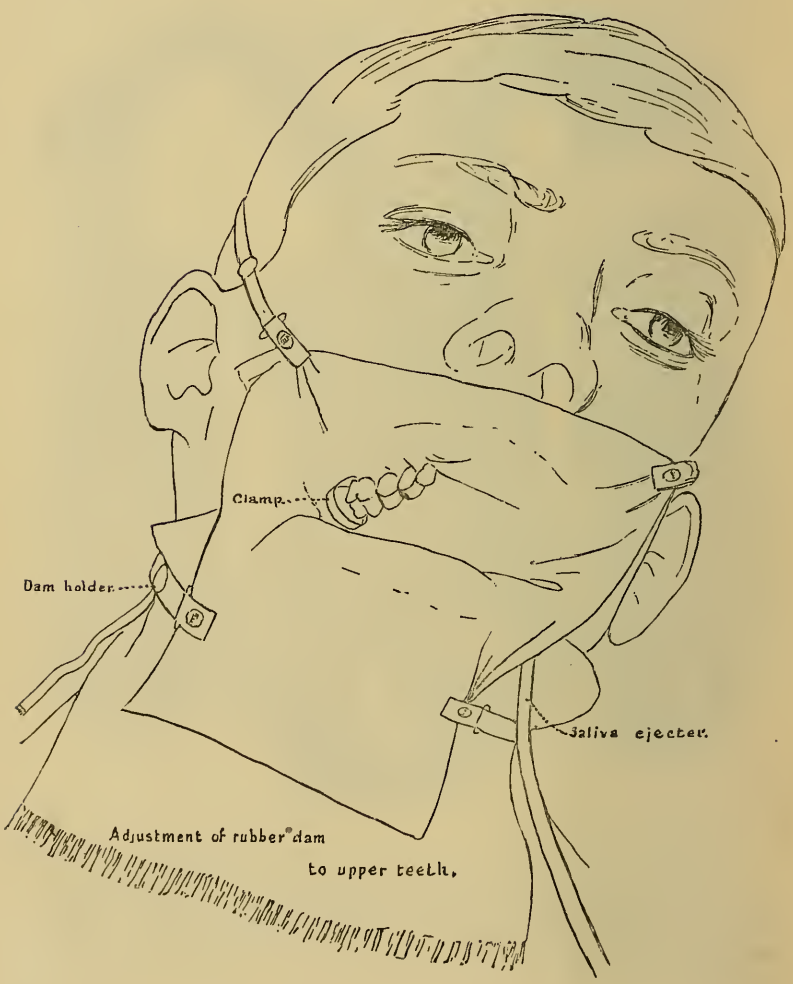


In some cases the clamp may be applied to the tooth first and the rubber stretched over it and the silk applied. This may be readily done if the hole in the rubber is made a little larger than usual.

An assistant, if at hand, may, with an instrument, hold the rubber down on the neck of the tooth while the silk is applied.

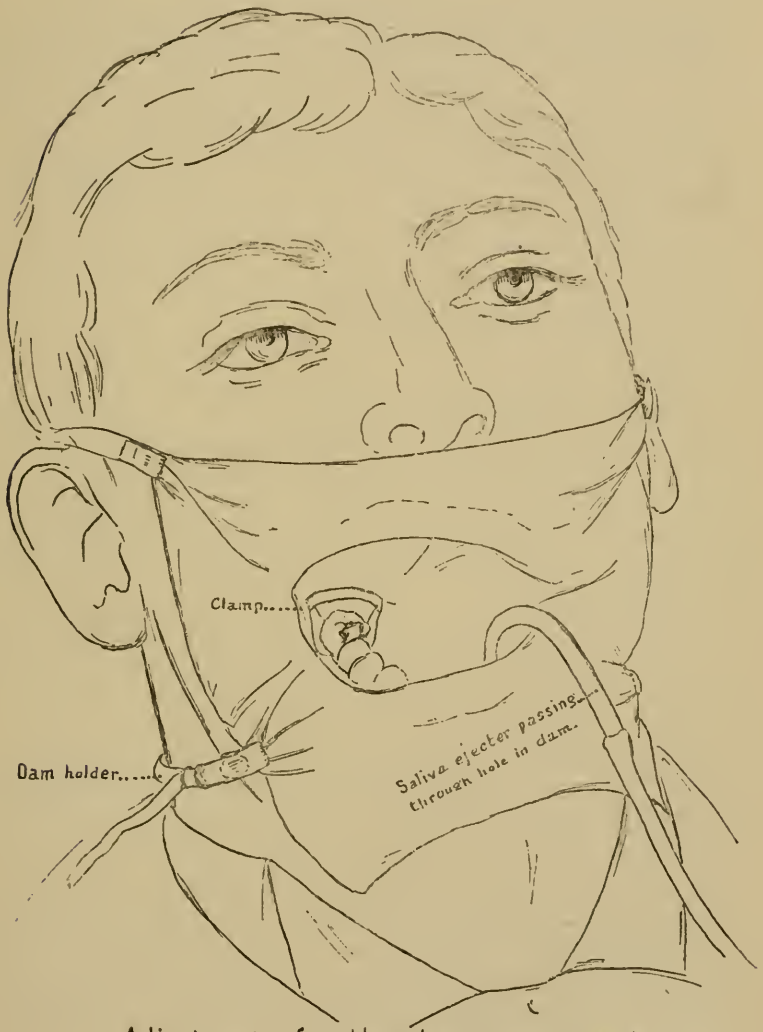
When the silk is to be applied far back in the mouth, it

FIG. 71.



may be wound around the little finger of each hand and with the forefingers carried back and pressed down between the teeth.

FIG. 72.



Adjustment of rubber dam to under teeth.

GOLD FOR FILLING.

Gold is the most elegant material for filling teeth that we possess, and for most cases it is the best. Though not the color of the tooth, it receives and retains so fine a polish that it is less objectionable than any other material.

Gold is prepared in two forms—foil and crystal or sponge gold. Foil is used cohesive and non-cohesive. Non-cohesive foil is so prepared that it will not cohere when the surfaces are brought in contact. Cohesive foil is prepared by annealing so that the particles will cohere when the surfaces are brought in contact, and it may thus be welded into a solid mass while cold. For instance, two sheets of foil, well annealed, laid together and pressed by passing over them a paper-folder, become united as one sheet.

Most of the non-cohesive foil now made may be rendered cohesive by annealing.

A sheet of gold foil is four inches square. It is numbered according to its weight, a sheet of No. 3 weighing three grains; of No. 4, four grains, etc. A book is one-eighth of an ounce. Foil is used of various thicknesses, from No. 2 to No. 120, or thicker. Gold in Nos. 20 to 240 is prepared by rolling, while foil thinner than No. 20 is made by beating the rolled gold to the required thinness.

Gold foil may be prepared for use in various forms, as the rope, the tape, the mat, the compact and the loose block, the compact and the loose cylinder, and the ribbon.

For use cohesively, cut the foil into strips of one-fifth or one-fourth of a sheet, and roll into ropes with a napkin, or, better, with the Adams roller, then cut into pieces one-fourth of an inch or more in length, according to the convenience of the operator and the requirements of the case.

For rolling the foil, take a large napkin or fine towel and fold lengthwise to a width of four or five inches, then fold this once upon itself, and, placing the strip of foil in the fold, by a dexterous movement of the upper portion of the napkin upon the lower it may be rolled into a rope.

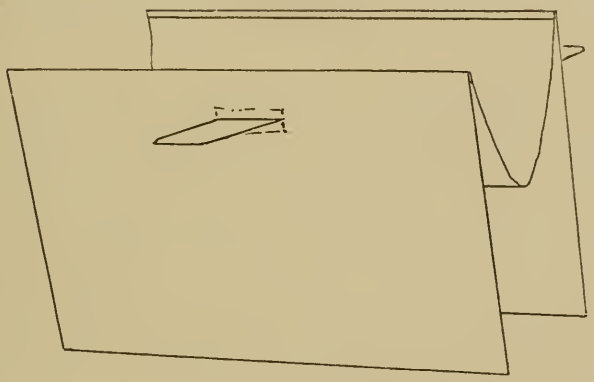
The Adams Roller consists of two plates of tin, three and a half by five inches, with the edges turned over and a small handle attached to the outside of each plate and a piece of thick rubber dam of the same size.

The edges of the rubber are confined to the upper edge of each plate by folding the tin upon itself and hammering it down closely upon the rubber. (Fig. 73.)

The rubber should first be thoroughly washed, and whenever the gold has a tendency to stick to it the washing should be repeated.

In the use of this the rubber is folded upon itself, the strip

FIG. 73.



of gold laid within it, crumpled a little endwise with pliers, and then dexterously rolled into a rope.

The following excellent directions for preparing gold in various other forms are given by Dr. Jack, in the "American System of Dentistry":—

"The tape is made by folding any portion of a sheet over and over again until a desired width and thickness is produced. It is not, however, considered advantageous to have the number of folds in each tape greater than eight, which, when the gold is No. 4, makes the tape equal to No. 32. If

the tape is to be used in this form by folding it into the cavity, as will be described later, it should be of non-cohesive gold, since otherwise the adherence of the folds, as they pass and touch each other, becomes an impediment to consolidation. The tape is most conveniently formed by laying the suitable portion of the sheet upon a clean napkin or a piece of amadou, and after placing the edge of the gold spatula in the middle, the napkin and spatula are laid over to one side; this is done three times successively. By this means the gold is formed into a tape without the fingers having come in contact with it, which is a point of considerable importance, since the cleanest fingers will impart some soil to the foil."

"**The Mat.**—If it is desirable for any reason to use small portions of the tape, it is cut transversely in small pieces, which are called mats. These, when of non-cohesive gold, are of considerable use in very small cavities, and are also of use in large fillings when made of semi-cohesive gold. One form of tape is made by a tool which compresses the gold into this shape; if from this kind of tape mats are cut, they may be used with advantage if of very cohesive gold. The mat is of most service in proximate cases when there may not be sufficient room to introduce larger and thicker pieces of gold. These can be inserted edgewise between the teeth, and afterward be carried into place and consolidated according to the method of packing employed at the time. The mats of non-cohesive gold are frequently of service in filling the smaller sulci, particularly of bicuspids. In introducing cohesive-gold mats, the best results are produced by making thin layers of gold, since the force employed is more effective in producing thorough consolidation. If thick masses, like pellets, are employed, much of the force is distributed in overcoming the impediment presented by the corrugations.

"**The Block.**—The compact block is formed by folding a tape on itself a number of times, which is done by seizing it in the pliers and making turns of any desired size, either square or narrow. This form should be composed of non-cohesive

gold, as otherwise a mass of so compact a nature would become unmanageable by the cohesion of the layers. These blocks are useful in commencing large proximate cavities, they being used upon the cervical wall. Their form, the parallel directions of their layers, the plastic nature of the arrangements of the layers, and the softness of the gold comprising them, enable this part of the filling to be easily started. They are also excellently adapted to simple crown cavities where it is not difficult to effect their placement. This form of block has sometimes been erroneously styled a cylinder.

"The Loose Block is composed of cohesive gold, and is generally made of what is called corrugated gold, the purpose of the employment of the latter being to prevent the layers from touching at more than a few points. This form of block is made by laying sheet upon sheet until a number of layers are so placed, when the mass is cut into squares with a razor-like instrument. These blocks are useful only in building up gold upon a previously-established foundation of cohesive gold.

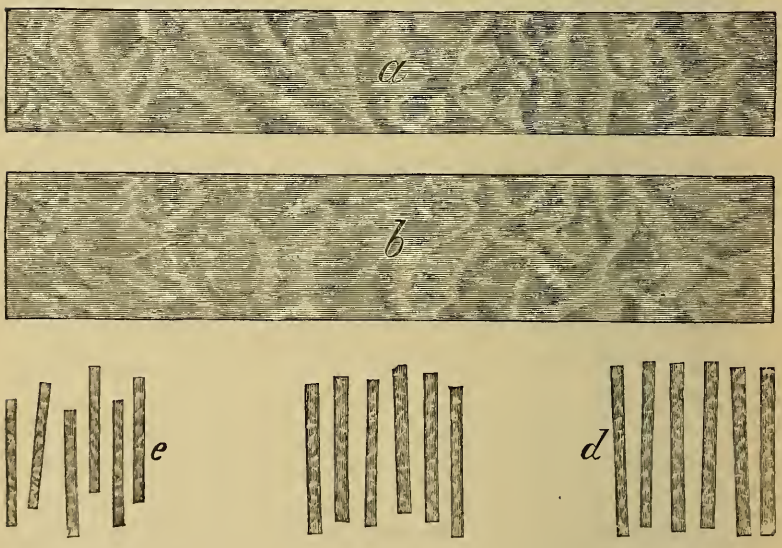
"**The Compact Cylinder.**—This form is made by rolling a tape of non-cohesive gold on a fine brooch, commencing at one end of the tape and continuing the movement until the desired size is reached, by which means the cylinders may be made very compact.

"The Loose Cylinder bears some external resemblance to the previous kind, but is in all other respects very different. Cylinders of this form can be made only by manufacturers. They are composed of several sheets laid one upon the other, and are then wrapped loosely upon a needle-like piece of steel. When the brooch is removed, they are cut into definite lengths by a sharp tool, and are distributed in assorted sizes. They are usually made of corrugated, cohesive or semi-cohesive gold, and they complement the loose block.

"They are employed in the commencement of fillings, for which purpose they are not usually annealed, and are recommended on account of the facility with which they can be packed. There is, however, considerable loss of force in

overcoming the corrugations of the foil of which they are composed. Still, there is no question that there are certain advantages possessed by these cylinders, as, when they are fixed at one end there is less danger of displacing this fixed portion when force is applied to the other end, for the reason that the corrugations permit some movement to take place in the unconsolidated part without disturbing the part first secured. Probably on account of the impediment offered by the corrugations, they are not well adapted to building out in

FIG. 74.



contour operations, and other forms should be substituted when this portion of the operation is reached.

"The Ribbon is formed of whole sheets, and, in some cases, of two sheets of flat cohesive foil, folded like a tape, three times, which produces No. 32 when one sheet is taken. The folding should be loosely done. These ribbons are shown at Fig. 74. The ribbons are taken up with delicate foil-pliers and cut across into little strips, represented at *d* and *e*, care

being taken to protect them from injury, the width of these strips being varied with the size of the case. Each of the strips is afterward taken up by pliers and heated to redness at the moment of using. It was with this form of gold that the beautifully-executed operations of Dr. Webb were generally performed.

"This form of gold is properly adapted only for building out teeth beyond the confines of the cavity, and for entirely filling such cases as depend for their support and retention upon a few retaining points or imperfect grooves which have been formed in weak margins. It is also the form of gold best adapted to the use of the electro-magnetic mallet, for the reason that, as that instrument is efficient only through insensible distances, it is important not to have much bulk of gold beneath its points.

"**Rolled Gold.**—Several thicknesses of heavy gold have been recommended, in some instances as high as No. 160 having been used. Reasonable practice in this respect has settled that Nos. 20 to 30 are the proper limits of heavy foil. Pure gold, prepared by rolling, has a remarkable degree of softness and toughness, and when made cohesive, manifests this quality in a higher degree than the same gold would if beaten into foil. When made of cohesive gold, and this property fully developed by heat, the adhesion is exceedingly tenacious, which adapts the gold for building out cases, and for surface fillings when it is important to produce a homogeneous appearance of the surface. When made of non-cohesive gold, narrow strips may be inserted along the margins of stoppings packed by hand pressure, and they may also be used for filling the pulp-canals. In this form it is not difficult to pack it into fine roots, and in this situation it will also well bear malleting."

The methods of packing non-cohesive and cohesive gold are essentially different. Non-cohesive gold should be packed wholly by the wedging process.

Pluggers for packing non-cohesive gold should be smooth

and wedge-shaped; those for condensing the filling after its introduction should have serrated points. They should be of various forms and sizes to suit the requirements of different cases. As most of these instruments are for use with hand pressure, the handles should be of suitable size and form to be firmly grasped by the hand, but the condensing instruments may be for use with the mallet.

The portions of gold of whatever form, whether blocks, cylinders, mats or tape, should be arranged generally in parallel layers, and they should be of sufficient length to extend from the bottom to a little beyond the margin of the cavity. Exceptions to this may be made in undercuts or depressions in the cavity or in the filling. A sufficient number of pieces are placed in the cavity to loosely fill it, a wedge-shaped plugger is passed into the filling and the gold pressed toward the sides of the cavity, and additional portions of gold should be added as at first, and the wedging process repeated. Continue this with smaller pluggers and smaller pieces until the cavity is full. Test every portion of the surface of the filling, and whenever a soft spot is found repeat the former process.

After the plugger is inserted, tipping it in several directions toward the edges of the cavity will increase its efficiency and more thoroughly pack the gold.

When the cavity is completely filled, the protruding gold should be condensed with a large, serrated plugger, followed by instruments of smaller size until the entire surface is thoroughly condensed.

Grind or file down the inequalities of the surface, burnish and then polish.

Cohesive gold may be packed by hand pressure or by mallet force. The packing surfaces of the pluggers, in either case, should be finely serrated and considerably broad, that they may carry the gold before them and not penetrate it.

Points for hand pressure may have great variety of form. The packing surface should be ovoid in form and it may present in any desired direction, but the surfaces of mallet

pluggers must present, in the main, in a line with the axis of the instrument, as all the force is applied in this direction. Sizes and forms are shown in chapter on Instruments.

A filling may be started in retaining pits or by placing in the bottom of the cavity pieces of crystal gold in sufficient quantity to extend across the cavity and be held in position by the opposing walls; or blocks, or cylinders of foil, slightly annealed, may be used instead of the crystal gold.

To continue the filling with ropes of foil prepared as previously described, a piece of convenient length is taken by the end in the pliers, passed over the flame of the lamp, and the end touched to the gold in the cavity, to which it coheres. With the plugger this is condensed, being folded upon itself or carried to other parts of the cavity. This is repeated till the cavity is full. The plugger is placed upon the gold, pressure exerted, and at the same time the plugger is rolled a little upon the gold, thus bringing all parts to bear.

While, theoretically, the crimps formed in the gold by rolling it into the ropes tend to hinder consolidation, yet when used in so attenuated a form as one-fifth of a sheet rolled loosely, it practically amounts to nothing, as so small a portion of gold comes under the plugger at any one time. The rope seems the better form because it is ready to be folded in any direction and lie in any part of the cavity. It may be used in convenient lengths, from one-fourth of an inch to four inches.

From two to six pounds pressure will be found sufficient to thoroughly consolidate the gold. A filling carefully packed in this manner will be found so solid as scarcely to yield to mallet force. Cylinders and blocks of considerable thickness may be perfectly condensed in this manner. Tape or ribbons may also be used in the manner described above.

Crystal Gold.—The best preparation of this form of gold is produced by electrolysis. It is prepared in different degrees of density, and is known as Nos. 1, 2 and 3, No. 1 being the softest.

This gold is specially useful in starting fillings without

retaining pits, as it is free from any tendency to curl or roll when condensed.

It is less reliable for margins than foil, but if skillfully manipulated, added in thin layers, and each layer thoroughly condensed, fillings may be made which cannot be excelled by any other form of gold.

Annealing Gold.—The first annealing of gold foil after being beaten develops its cohesive quality by causing a change in the molecular structure. Quite a high degree of heat is necessary for this purpose. Subsequent exposure renders the foil non-cohesive, owing to a condensation of gases or moisture from the air upon the surface. To restore the cohesive quality, a degree of heat sufficient to drive off these gases is needed, but this is far short of redness.

It is generally best to prepare the gold in the form and size required, and then anneal as it is used.

The annealing may be done by holding the gold over, or passing it through, the alcohol flame, or on a plate of mica or platinum over the alcohol flame or Bunsen burner.

The larger forms of gold, as cylinders and blocks, are best annealed by the latter method.

When gold is taken in the pliers for annealing, it should be seized by as minute a portion as possible, as the pliers condense the portion included and prevent its being properly heated.

THE DENTAL MATRIX.

The matrix, as used in dental operations, consists of a plate or band of metal so applied to a tooth as to supply a missing wall, and thus convert a compound cavity into a simple one.

Matrices formerly used were so made as to require support from an adjoining tooth. Those recently invented, which consist of a band embracing the tooth operated on, render other support unnecessary and are superseding the use of the former. The following are some of the recent forms:—

FIG. 75.

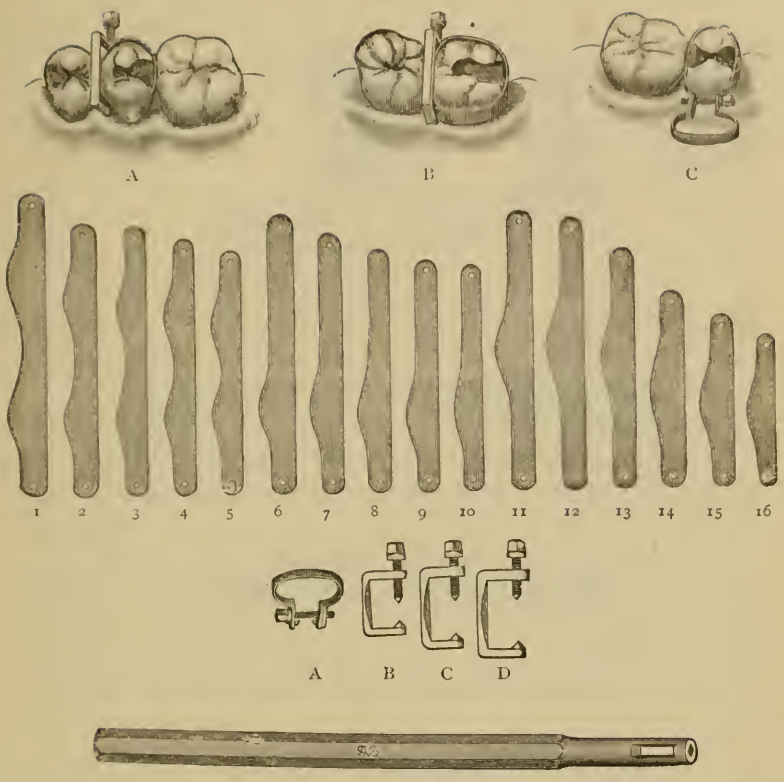


Fig. 75 represents Guilford's band matrix, which has the merit of passing into but one interdental space.

FIG. 76.

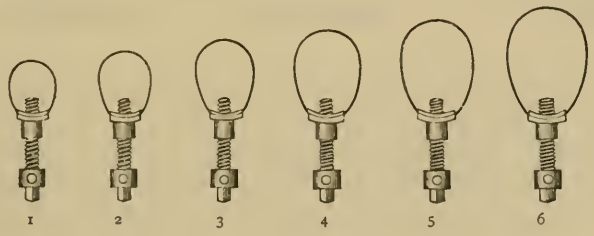
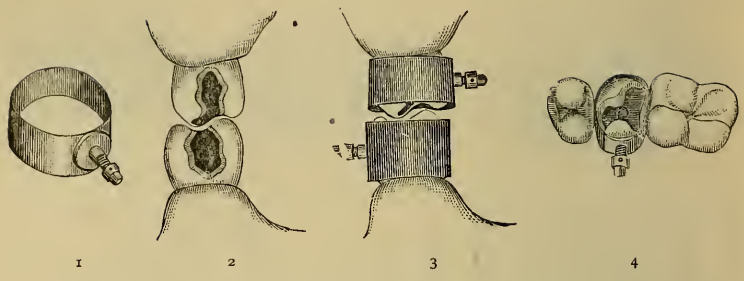


Fig. 77.

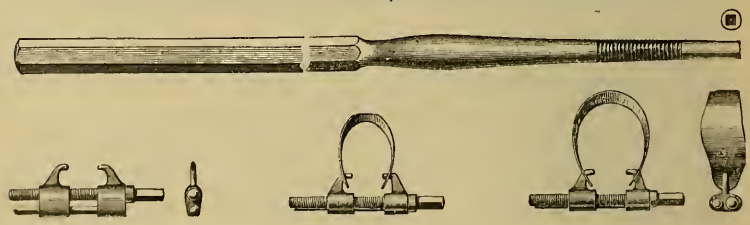


Figs. 76 and 77 show Brophy's band matrix. On the lower teeth it is better to place the screw on the lingual surface. They are in several sizes.

Herbst invented a matrix of ready application to any case. It is made by bending a piece of thin German silver or steel around the tooth and pinching it up with pliers, then removing from the tooth and soldering with soft solder. A little solution of zinc chloride for flux, and a bit of soft solder are applied and held in the flame of an alcohol lamp, and the solder quickly flows.

Fig. 78 represents the Ladmore-Brunton matrix and flexible key. It is a convenient and efficient device.

Fig. 78.

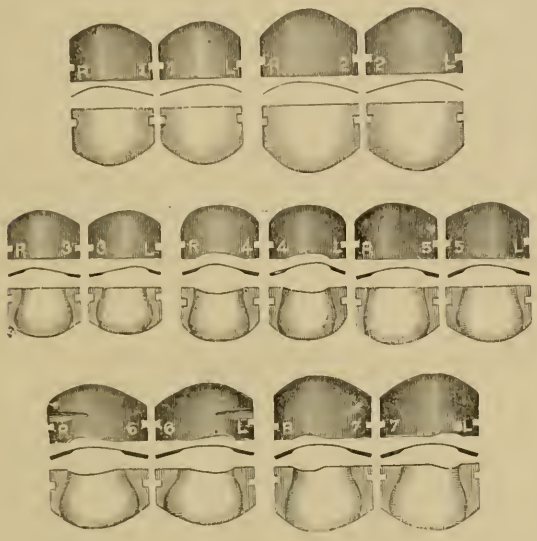


A good matrix may be made by striking thin metal from dies formed from the proximal surfaces of the teeth, and held in position by ligatures around the teeth. Projections may be left near the cervical edge to prevent the ligature from slipping against the gum, and some portion of the edge may be bent

over the grinding surface to prevent the matrix from slipping too far down.

Dr. Jack's matrices were the first formed specially for the purpose, and are shown in Fig. 79.

Fig. 79.



They are formed with a depression corresponding to the desired form of the filling, and are held in position by wedges against the adjoining teeth.

When a matrix is used in filling, great care should be taken to pack the gold thoroughly against the edges of the cavity and against the matrix, else these portions of the filling will be found imperfect when the matrix is removed.

USE OF THE MALLET.

In applying mallet force in the packing of gold the plugger point is placed upon the gold and a blow is struck upon the end of the handle.

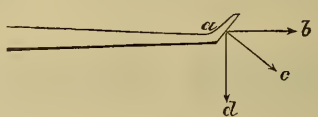
The mallet force is wholly in a line with the axis of the instrument, hence the packing surface of the plugger should be as nearly as possible at right angles to the axis of the handle. If pluggers with surfaces oblique to the axis are used, strong lateral pressure should be made when the blow is struck, so that the resultant force will be in a line with the face of the plugger. (Fig. 80.)

Better results are obtained if the face of the plugger is quite broad and a little oval. The serrations should be very fine and shallow.

The blow may be struck with the hand mallet, the spring mallet, the engine, the pneumatic or the electric mallet.

The hand mallet may be used by the operator himself, holding the plugger in one hand and striking the blow with the

FIG. 80.



The line *a b* represents the direction of the mallet force, *a d* the lateral pressure, and *a c* the resultant force.

other, or the mallet may be used by an assistant. All the machine mallets are used by the operator.

The blow should be rather light, but sharp and quick, that the force may be expended upon the surface of the filling, as a slow, heavy blow tends to carry the force to a greater depth and to spread the mass of the filling, and thus injure the tooth.

A considerable thickness of gold should be placed at the margins of the cavity before the plugger is used, so that the blow may not injure the enamel.

Much malleting should be avoided, as more than enough to condense the gold only tends to harden it, thus making it less cohesive, brittle and disposed to draw away from the sides of the cavity.

All the forms of gold previously mentioned may be condensed by the use of the mallet.

Generally, one blow in each position of the plugger is sufficient, but if large pieces of gold are used, or if the blows are very light, two or more may be of advantage.

One method is to exert considerable hand pressure upon the plugger when the blow is delivered; another is to simply hold the plugger upon the gold, and depend wholly upon the blow to condense it; and a third, used in the later stages of the filling, is to hold the plugger in almost immediate contact with the gold, the blows being light and delivered very rapidly, constantly changing the position of the instrument over the gold as the electric mallet is used.

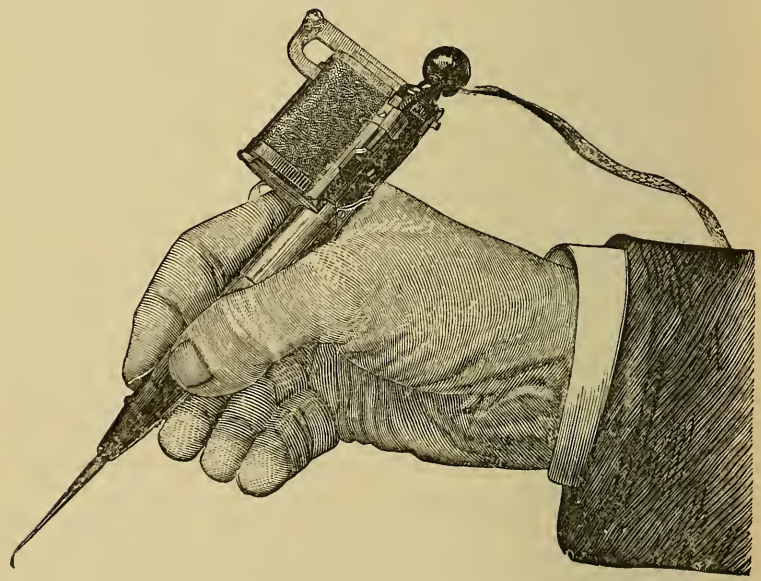
The automatic mallet, in which the blow is struck by the expansion of a spiral spring, is in more general use than any other, and best serves the purpose of the average operator. The blow may be accurately regulated, from the lightest tap to one as heavy as is ever required.

With the engine mallet the blow is struck by the action of a cam on a pulley driven by the engine, which, as it revolves, strikes upon the end of the plugger, and thus impacts the gold. It strikes from fifteen to twenty blows per minute, and should be held in the fingers as a pen is held in writing, and thus freely moved about at such a distance from the surface of the filling that when the point is projected by the blow it will impinge upon the gold with sufficient force to condense it.

The electric mallet is a desirable instrument, and is preferred by many operators. As the action is exceedingly quick, the blow has eminently the quality of velocity. "It is for this reason that the blow of the light armature of this instrument is so powerful. The impaction of gold by it exceeds in solidity that produced by any other means. If the faces of the instruments are fine or nearly smooth, the state of the gold, if cohesive, is one of absolute solidity. The point of the instrument is driven forward the merest fractional distance; hence it can be used for packing gold against the frailest walls.

"The instrument is held in the hands as it appears in Fig. 81, and is handled with a touch which is difficult in language to describe. The point is not applied to the gold with some pressure, as other instruments are, but is simply touched to the surface of the mass, and in this free state is rapidly skimmed over the gold, the ear all the while being guided by the sound of the plugger on the gold, which, among the other noises of the instrument, is clearly observable by the expert operator.

FIG. 81.



"When sensible pressure is employed the action of the instrument becomes excessively disagreeable and cannot long be tolerated; but when the touch of the operator is delicate, long operations are endured without notable irritation. The delicacy of manipulation indicated by the above language will necessarily limit the use of the instrument to comparatively few persons. The facility of its use can be acquired only by

personal contact with those skillful in its handling. It is an essential precaution that under no circumstances should the point of the instrument come into contact with the margins of the cavity, but should always be so handled as to be preceded by the presence of a layer of gold. For the reason just given, no description of the particular manner of impacting gold with it is made.

"The field requiring the employment of this mallet and the cultivation of facility with it is in the large contours and the necessarily exposed fillings of front teeth, which demand that degree of solidity which enables the most perfect finish to be given to them. This instrument is well adapted to teeth of soft texture and of frail character, for the reason that the blows of the instrument are superficial in their effect; hence, there is no danger of the borders being injured by the application of its force, as may be the case when heavy hand-force is employed, or disintegrated, as when other mallets are used.

"The management of the galvanic batteries connected with the instrument has been considered an obstacle, but it is one which has no force with a properly educated dentist, who should be familiar with all the chemical principles involved. Having this knowledge, there are no impediments to be encountered."*

The several forms of gold and the several methods of condensing may often be combined to advantage in the filling of a single cavity. It saves time and is restful to the operator, and these are important points in long operations.

The filling may be well begun with blocks or cylinders of semi-cohesive gold packed either by hand pressure or with the mallet, and to this may be attached any of the preparations of cohesive gold packed by any method preferred, and, if readily accessible the filling may be finished with ribbons and the electric mallet.

A plan practiced by many, especially in proximal fillings, is

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* Dr. Jack, in "American System of Dentistry."

to pack at the cervical wall a layer of non-cohesive gold; this is followed by a layer of semi-cohesive blocks or cylinders; then from this continue with cohesive gold as desired.

Another plan is to fill the margins and the body of the cavity with semi-cohesive gold, filling the centre and finishing the filling with cohesive.

PLASTIC FILLINGS.

Amalgam, Oxychloride of Zinc, Oxyphosphate of Zinc, and Gutta-Percha are the plastic fillings now used.

Amalgam is the only plastic metal filling. It is compatible with tooth substance, consequently tooth-saving; it has comparatively low conducting power, hence it is less likely than gold to produce inflammation of the pulp; it is easily introduced into the cavity, hence it is applicable in places difficult of access and in cavities with frail walls. It is thought by some, however, to exert a deleterious effect upon frail enamel walls. Its color is objectionable, and it is inclined to assume the spherical form and consequently to draw away from the walls of the cavity. Careful preparation and thorough packing will greatly modify, if not entirely overcome, the shrinkage and the tendency to assume the spherical form, and will add greatly to its preserving qualities, and nice polishing and burnishing will improve the color.

The best amalgam is fine-grained, plastic-working, sets quickly, has good edge-strength, sufficient hardness to resist wear and density to take a good polish.

Silver, tin and mercury are the essential constituents of amalgam. Gold, copper, zinc and other metals are frequently added in proportions varying from three to seven per cent.

Gold decreases the shrinkage and improves the color, and copper is thought to have a preservative effect on the dentine, and to render the filling less likely to induce irritation of the pulp in deep cavities. Zinc, not exceeding one and one-half per cent. of the alloy, renders the amalgam more plastic,

thus improving its working qualities. It also improves the color, and for this object it may be used in larger quantity, even to ten per cent., but the plasticity of the amalgam will be lessened.

Cadmium must not be used, as it is highly destructive to the teeth.

An amalgam is made of copper and mercury only, which is serviceable. It becomes very dark in color, but it saves the teeth well and does not stain. It neither shrinks nor expands.

Silver and mercury alone make an amalgam very hard, dense and serviceable, but it turns very dark in color, owing to the sulphide of silver.

Tin so modifies and improves the filling that it has come to be esteemed an essential element of all silver amalgams. It makes the alloy amalgamate much more easily, makes the filling finer grained, more plastic, and improves the color from the first and prevents its turning dark. It softens it, but not to its detriment. The proportions in which tin is used range from thirty-five to sixty per cent. of the alloy.

To prepare an amalgam filling, place a sufficient quantity of the filings in a small wedgewood or ground glass mortar, or in the palm of the hand, add mercury, and rub them thoroughly together with the pestle or with the finger; add, if necessary, a little more of the filings to harden, or mercury to soften. The paste should be soft enough to cohere when pressed, but hard enough so that mercury may not be expressed by pressure between the thumb and finger. A little practice will enable one to judge correctly. A balance may be used with good results by pouring the filings in one end and the mercury in the opposite cup, the balance showing the proper proportionate weight of each. The balance must be adjusted for each quality of alloy.

Have the cavity dry and protected from moisture, insert the filling in small pieces, placing it in perfect contact with all parts of the walls of the cavity by rubbing and gently tapping with the plugger, exercising the same care as with a gold filling,

especially at the cervical wall and in undercuts. The tapping process condenses amalgam with remarkable facility and thoroughness.

Amalgam may be very thoroughly and satisfactorily packed by inserting enough to half fill the cavity, covering with a layer or a pellet of cotton or bibulous paper and rotating the burnisher upon this with pressure, either with the engine or with a hand burnisher. Then add more amalgam and repeat the burnishing until the cavity is filled.

Remove surplus and burnish toward the edges until it has begun to set, then leave it, and at a subsequent sitting dress down and polish.

If the tooth to be filled is much broken down, there may be adjusted to the tooth a band matrix, cut to fit the occlusion and filled and allowed to remain until the amalgam is hard, when it may be removed and the filling finished as in other cases.

Amalgam was formerly washed in alcohol or solution of bicarbonate of soda, but at present this is not in favor, and it is thought it injures it. This is questionable.

Copper amalgam is especially adapted to the filling of buccal cavities in teeth of inferior quality. It seems to exert a preservative influence. Its extreme hardness is an objection to its use in proximal cavities, as it is almost impossible to cut it, if its removal should from any cause become necessary.

GUTTA PERCHA.

Gutta percha for filling is used combined with oxide of zinc, and was first known as Hill's stopping, and since by many other names. It is useful for temporary fillings, for root filling, and for cavities with frail walls or if near the gum. In some instances it lasts a long time, ten years or more, but when exposed to wear it is soon destroyed, and some preparations of it are softened by the secretions.

It is best used by cutting in small pieces, laying them on a

warm slab of porcelain or tile until soft, and inserting one piece at a time until the cavity is full. Each piece should be warm enough to stick to the walls or to the portion already inserted, and thus make a homogeneous filling.

A coating of resin dissolved in ether applied to the walls of the cavity will cause the gutta percha to adhere firmly. Chloroform or oil of cajeput on the burnishers will soften the surface and aid in finishing.

CEMENTS.

Oxychloride of zinc is useful for root fillings and for partially filling cavities in crowns of teeth to whiten them. It is the lightest colored cement made. It is not serviceable for exposed fillings, though in a few exceptional cases it has lasted seventeen to twenty years.

Mix the liquid and powder on a palette to the consistency of thick paste, and insert in the cavity. Wait for it to harden and finish at same sitting. For use in root canals, see page 101.

Oxyphosphate of zinc is phosphoric acid and calcined oxide of zinc. This has almost entirely superseded the oxychloride of zinc for exposed fillings, as it is much more durable.

Mix with a flexible spatula, on a slab (a glazed tile four inches square), the acid and powder to the consistency of soft putty, working in the powder thoroughly, a little at a time, rubbing well with the spatula until it works smooth, and continuing the working until used, as it begins to set immediately on being allowed to rest. Insert quickly in convenient portions and insure perfect contact with the walls of the cavity, which should be perfectly dry. Dress off the surplus with a thin cutting instrument, well oiled, then burnish slightly toward the edge with oiled burnisher. Do not burnish hard enough to move the body of the filling after it has begun to set, as it breaks up the crystallization. The filling should be kept dry from fifteen to thirty minutes. It is well to cover it with gutta percha dissolved in chloroform and allow it to

remain to protect from moisture until it is fully hardened. When making permanent fillings it is better to use the rubber dam.

A good oxyphosphate of zinc filling may be expected to last from one year to five years.

The cervical wall may be protected with gutta-percha amalgam or tin filling and the cavity then filled with the cement, and thus be made more durable.

For use as temporary fillings the cement may be mixed much thinner and used quickly, and not kept dry. Such fillings may be cut out quite quickly.

A temperature of about 70° F. is the most favorable for mixing cements.

COMBINATION FILLINGS.

Gold and platinum are sometimes used in combination, being beaten together in the manufacture, the platinum between two layers of gold. This is manipulated in the same manner as cohesive gold. When finished and burnished the platinum comes to the surface and modifies the color of the filling according to the amount of platinum in the foil, rendering it less bright. The combination is also much harder than pure gold, a desirable quality for grinding surfaces or exposed edges.

A combination of gold and tin is made by laying together a sheet of gold and of tin, each No. 3, and then rolling this into ropes and preparing as directed for gold foil. This must be used as non-cohesive foil. It is claimed that this preserves the teeth better than gold; it is more easily packed than gold, and is harder than tin.

Fibrous foil is used in combination with gold as a foundation in large crown cavities or at the cervical wall in proximal fillings.

As much of the fibrous foil is used as seems desirable, and to this the gold foil is added and the filling finished.

Amalgam, also, may be used as a foundation, allowing it to thoroughly harden before adding the gold.

Recent experiments show that electric currents exist between fillings of dissimilar metals in the mouth, but whether enough to prove injurious or not is not definitely settled.*

PORCELAIN DISK FILLINGS.

These fillings are often preferred in cavities exposed to view to avoid a show of metal. They are disks of porcelain of a size and thickness to fit the cavity to be filled. They may be carved and baked specially for the case or ground from a tooth selected for the purpose. The dense body of the English tooth is excellent for this purpose, as a surface which has been ground will take a fine polish.

Prepare the walls of the cavity to be filled perpendicular or a little undercut. The outline may be of any convenient form, but there should be no sharp angles. Grind the porcelain to the proper thickness, and get a pattern of the outline of the cavity as follows: Lay a piece of pattern tin over the cavity and burnish around the edges to mark the exact outline, being careful to avoid depressing the tin over the cavity, as this would make the pattern too large. Cut the pattern to the outline thus obtained, and test its accuracy by trial in the cavity, then cement it to the porcelain by placing upon the latter a grain of gum shellac, and, holding this in the flame of the burner until the gum is melted, place the tin pattern on the shellac and press it closely. When cool it will be found to be firmly attached and the surplus porcelain may be ground away, leaving the disk of the size and form of the cavity. Then reduce the thickness until, when placed in position, the disk is but little raised above the surface of the tooth.

Having the disk thus prepared, the rubber dam applied and the cavity dry, mix some oxyphosphate rather thin, so that any surplus may escape around the filling, then partly fill the cavity with the cement and press the porcelain firmly into place.

* Dr. Whitefield, in *Western Electrician.*

Gutta percha may also be used for setting. Use a soft grade and place a sufficient quantity, well softened by heat, in the cavity, and, having the porcelain also well heated, press it firmly into the cavity, from which the surplus gutta-percha will flow out around the filling.

Give time for the cement or gutta-percha to harden, and then grind the porcelain to proper contour and polish it.

Some prefer to grind the porcelain a little smaller, to allow of the removal of a portion of the cement or gutta-percha, and the insertion of a narrow gold filling around the margin.

EROSION.

The affection of the teeth known as *erosion* or *abrasion* is characterized by loss of substance. It appears on the enamel in irregular patches and in grooves across the necks of the teeth, these spots and grooves presenting a smooth and polished surface.

The upper incisors and cuspids are the most frequently affected. Other classes are affected, as to frequency, in the following order: upper bicuspids, lower bicuspids, cuspids and incisors. The grinding surfaces of molars are frequently attacked, and sometimes the cutting edges of incisors.

The cause is unknown. It is attributed to the acid secretion of the mucous follicles, to defective structure, and to the use of stiff brushes and coarse, sharp powders. Weakened nervous power is recognized as a predisposing cause.

Treatment.—Make the secretions healthy and advise the moderate and regular use of a soft tooth-brush with alkaline dentifrices. No powder coarser than precipitated chalk should be used. Covering the teeth at night with a paste of phosphate of lime is advised, but nothing has yet been found to entirely arrest its progress. When far advanced, filling is the only remedy, and this will not prevent its extension.

If bicuspid or molar teeth are much affected, a gold cap may prove serviceable.

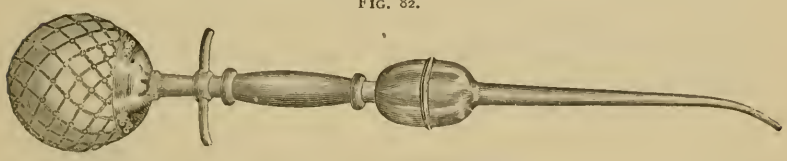
SENSITIVE DENTINE.

Dentine may be hypersensitive in all parts of a tooth, or only in isolated spots. A line near the gum on the surface of the tooth is frequently affected.

When dentine is exposed by decay, certain portions will be found unusually sensitive. The location of these sensitive areas may be different in each case, but the most sensitive points will be found somewhere in the layer of dentine next the enamel.

The sensitiveness arising from decay may always be lessened by applications, though not in all cases entirely overcome. The most useful agent is dryness. Use the hot-air syringe (Fig. 82) or the ordinary chip-blower, the bulb being filled with heated air by drawing in the flame of the alcohol lamp.

FIG. 82.



As dryness is so essential, it is advised to apply the rubber dam, when practicable, before commencing to operate.

Of medicinal agents phosphoric acid is probably the most effective. That its effect is wholly without injury to the dentine, may be considered as still in doubt. When used, be sure to remove or neutralize all the acid before filling. Cocaine, carbolic acid, creasote, chloroform, ether spray, glycerite of tannin, chloride of zinc, nitrate of silver, caustic potassa and bicarbonate of soda in solution are often effective.

Any application for this purpose should be applied to the dry surface and allowed to remain from five to twenty minutes, and the dentine may be removed as far as the sensitiveness is destroyed, when the application must be repeated. Phosphoric acid and zinc chloride usually produce more or less pain for a short time.

The following is the formula for the Herbst obtundent:—

Take of—

Sulphuric acid	1 drachm.
Hydrochlorate of cocaine	30 grains.
Sulphuric ether	3 drachms.

Dissolve the cocaine in the acid and add the ether.

The following is excellent:—

Take of—

Sulphuric ether	1½ fluidrachms.	
Cocaine (alkaloid)	10 grains.	Mix.

The galvano-cautery is said to be efficient and is worthy of trial. It should be passed quickly over the surface.

Arsenious acid should *never* be used as an obtundent of sensitive dentine, unless it is determined to devitalize the pulp, as this result is sure to follow. If used, the pulp should be exposed and removed at once, or as soon as possible, to avoid discoloration of the tooth.

SECONDARY DENTINE.

Dentine which is formed by the pulp after the tooth is fully developed is called secondary dentine. It differs in its structure from true dentine, the tubuli being more like the canaliculi of bone. The tubuli are very irregular, without any centre of radiation, as is the case in normal dentine, the tubuli of the latter radiating from the pulp cavity.

The tubuli of secondary dentine are completely filled with calcific material, hence it is very translucent.

It is formed as a continuation of primary dentine, sometimes to such an extent that the pulp is nearly obliterated. In other cases it is deposited in isolated nodules, or in a granular form in the pulp tissue.

When formed as a covering for a receding or nearly exposed pulp it cannot be considered pathological. It is then called protective dentine, or dentine of repair, but when it is produced

in so great quantities as to cause pressure upon the pulp, or in irregular forms in the pulp, it assumes a pathological character. In the teeth of aged persons, the crowns of which are much worn down, secondary dentine is sure to be formed, and usually round, light-colored spots may be seen, showing the places formerly occupied by the cornua of the pulp.

Pulps which have been for a long time nearly exposed, or to which fillings have been in close proximity, frequently contain nodules or granular deposits. Sometimes a single nodule takes the form of the pulp cavity and nearly fills it.

The immediate cause of secondary dentine is an irritation of the pulp, the remote cause being the source of this irritation, as the abrasion of mastication, the force of occlusion or a blow; and while it is a result of irritation it finally becomes an irritant to the pulp which formed it, hence the symptoms are the same as of irritated pulp, but more persistent.

When formed so as to produce these pathological conditions there is no hope of recovery, and no remedy except removal of the pulp.

The temporary as well as the permanent teeth are subject to the formation of secondary dentine, but not to an equal extent.

Treatment.—Drill into the tooth, devitalize the pulp and remove as much as possible, drill any remaining portion from the canals, and fill as in other cases. The pulps are usually so hard in these cases that a broach will not pass into the canals, and the drill must be resorted to, and often when the pulp is reduced to a fine line health and comfort cannot be obtained until it is drilled out.

When nodules are present devitalize the pulp, if possible, and remove them. If sensitiveness persists after the use of arsenic, as is very likely, apply sedative obtundents and cut away the overlying plate of dentine until the aperture is large enough to permit the passage of the nodule, when a small hook may be gradually passed by and the nodule drawn out. The sensitiveness of the pulp is, in such cases, very persistent, and

great patience must be exercised in its devitalization and removal.

THE DENTAL PULP.

The following are conditions of the healthy pulp needing treatment :—

Sensitive Pulp.—Decay has nearly reached the pulp, and the dentine over that portion is especially sensitive to the light touch of an instrument, and these are the signs by which the condition is recognized.

Treatment.—Bathe freely with wood creasote, and after absorbing the surplus cover the sensitive parts with prepared chalk Sometimes strong carbolic acid is used instead of creasote. Place upon this some non-conducting and non-irritating substance, as asbestos, gutta-percha dissolved in chloroform, or oxyphosphate of zinc, and over this insert the permanent filling, avoiding pressure over the sensitive parts.

Partially Exposed Pulp.—In this case the overlying dentine is partially decalcified and generally more or less discolored. The symptoms differ from those of sensitive pulp only in degree, and the condition must be recognized by physical signs, especially by extent of decay and by touch.

Treatment.—Leave a portion of the partially decalcified dentine over the pulp for protection and treat as described for sensitive pulp.

Exposed Pulp.—*Symptoms.*—The pulp is sensitive to touch. It appears as a small grayish-white spot in the dentine, and may be detected by sight, or by the very delicate touch of a fine-pointed instrument.

Treatment.—Cap the pulp with a solution of gutta-percha in chloroform, adding oxyphosphate or oxychloride of zinc for protection, the latter mixed thin and applied without pressure, or bathe the exposed pulp for some minutes with creasote, and then cap with oxyphosphate of zinc.

A method much in favor with some is to cap the pulp with a paste of creasote or carbolic acid and oxide of zinc, placing

over this, for protection, a portion of the oxychloride. Fill the cavity with any material desired.

DISEASES OF THE PULP.

Irritation.	Congestion, Inflammation.
Fungus.	Suppuration.
Fatty degeneration.	Calcification.
Atrophy.	Mummification.
Putrescence.	

Mummification and putrescence are conditions resulting from disease.

Irritation.—*Symptoms.*—Sensibility becomes very much exalted—a state of hyperæsthesia; the pulp is easily excited, but pain produced soon subsides.

Treatment.—Subdue the irritation with creasote, oil of clove, chloroform, or equal parts of creasote and oil of clove. Unless the irritation borders on inflammation, insert oxyphosphate at once and let it remain several weeks; then, if no trouble arises, insert the permanent filling. If in the meantime pain arises, remove the temporary filling and treat the pulp for congestion or inflammation.

Congestion and Inflammation.—The essential feature of congestion is an undue fullness of the blood vessels with the return flow of blood retarded. Sensibility is not much increased, and pain is not severe, but is dull and heavy. If the congested organ is wounded, blood flows freely.

In inflammation, the amount of blood is still greatly increased, with complete stasis at some point, accompanied by effusion and exudation through the walls of the vessels. Pain becomes sharp, severe and paroxysmal, and often throbbing. There is extreme sensibility to touch and to thermal changes.

Treatment.—A *congested* or *inflamed pulp* is very unlikely to become healthy. If quiet for a time, it gradually loses its vitality and sooner or later gives trouble, but an effort should be made to save it, and in some favorable cases success may be obtained. Cleanse and dry the cavity, and apply creasote and oil of clove to allay the sensibility and pain. If neces-

sary, for the relief of pain, prick the pulp and allow it to bleed; then apply creasote and cover with cotton and sandarac varnish, or a mixture of equal parts pink gutta-percha and beeswax, sealing the cavity perfectly. Change the dressing daily until the pulp is apparently restored to health, then cap and fill temporarily.

If the pulp cannot be made healthy, or if the diseased condition recurs, devitalize and remove it.

The presence of nodules of secondary dentine in the pulp renders it very difficult, or quite impossible, to relieve the inflammation, and devitalization and removal is the only remedy.

If the pulp develops a fungous growth, the application of a little strong nitric acid will destroy it with but little pain. Dry the pulp, and with a wood toothpick apply a drop of the acid.

Remove at once all mummified, calcified, atrophied, fatty and putrescent pulps.

Devitalization of the Pulp.—If painful, quiet with creasote, or better, with creasote and oil of clove, equal parts. Arsenic increases the pain. After remaining twenty-four hours free from pain, or nearly so, apply arsenic as follows: Take a pellet of cotton the size of a pin-head on a small excavator and saturate with creasote; touch the cotton to some substance to absorb the excess of creasote, then touch to the powder of arsenious acid, taking what will adhere to one side of the pellet. One-fiftieth of a grain is sufficient. Apply this accurately to the exposed portion of pulp and cover with gutta-percha and wax, or cotton and sandarac varnish. Avoid pressure.

Instead of pure arsenic the following may be used:—

Arsenious acid	Equal parts.
Tannic acid	
Sulphate or acetate of morphia	

Mix thoroughly.

It is important to fully expose some portion of the pulp, to

allow blood or serum to escape, and thus prevent pain from congestion, and also prevent discoloration of the tooth from infiltration of the coloring matters of blood into the dentine.

The arsenic must not be allowed to touch the parts around the tooth, as serious sloughing of the soft parts and exfoliation of bone may result from its action.

In many cases arsenic will effect the devitalization of the pulp in six hours or in less time, but it may usually remain twenty-four hours, and if the pulp has resisted its action, as much of it as practicable may be removed and the application repeated. If allowed to remain several days or even weeks, ordinarily no harm will result.

Removal of the Pulp.—After devitalization, cut away the dentine with excavators, chisels, or burs, so as to obtain free access to the pulp cavity, then remove the pulp with barbed broaches or hooks. Press the pulp gently to one side and pass the broach up the canal as far as possible. Pushing upon the pulp should be avoided, as it produces more pain than traction.

If the pulp be treated for a few days with tannic acid and creasote it may generally be removed entire, but sometimes it will be more or less broken up, and any remaining shreds may be removed with a little cotton wound on a broach and rotated in the canal.

The conical reamer will be found valuable to enlarge the opening of the canal, if needed, to more conveniently reach the apex.

If the pulp is not readily accessible through a cavity of decay, drill through the lingual surface of incisors or cuspids or the grinding surface of bicuspids and molars, though sometimes in inferior bicuspids it is better to drill through the buccal surface at the neck of the tooth.

Frequently an inflamed pulp will prove very resistant to the action of arsenic or of sedatives, and many sittings will be required to accomplish its removal, and in many cases pericemental inflammation will be excited before the sensitiveness

of the pulp is destroyed. For this there is no remedy known, except the continued application of sedatives. Slight pressure upon pulp tissue which is dead or even putrescent, will sometimes produce pain; this is due to the communication of the pressure to the inflamed tissue beyond. In these cases the dead tissue should be gently *drawn away* with small excavators or hooks.

In children's teeth be careful to not pass the instruments used in the removal of the pulp through the foramen, as it is large.

Extirpation of Pulp by Operation.—The pulp may be removed by immediate extirpation by means of a barbed broach, or by a drawn-temper nerve needle with the point bent to form a small hook.

After fully exposing the pulp, press it to one side with an excavator, and pass the instrument up between the pulp and the wall of the canal as far as possible, then rotate the instrument to entangle the pulp, and withdraw the instrument, bringing the pulp with it. This operation may be rendered less painful by the application of atropine, chloroform, carbolic acid, or cocaine. While this method may often prove successful without much pain, yet in the majority of cases an anæsthetic will be necessary.

General Anæsthesia in Removal of the Pulp.—Nitrous oxide gas will usually be preferred for this operation. Cut into the tooth at some point from which the pulp canal is accessible, as deeply as the sensitiveness of the tooth will permit. Have the engine at hand armed with a sharp, round bur, No. 6 or 7, and also instruments for the removal of the pulp. Then give the gas, and during the anæsthesia drill into the pulp chamber, enlarge the opening until the canal can be readily entered, and with the nerve instruments remove the pulp.

A method practiced to some extent, and often successful when there remains a considerable portion of the crown, is as follows: With a bur in the engine, cut a deep channel around

the neck of the tooth. Have at hand a piece of orange wood or hickory, whittled at the point to about the size and form of the root canal, then with a pair of excising forceps (Fig. 83),

Fig. 83

the beaks placed in the channel, cut off the crown. Immediately insert the wood point by the side of the remaining pulp and drive it gently, but thoroughly, into the canal with the mallet, turn the point around and remove it, and the crushed pulp will be found adhering to its surface. The shock of the excision so benumbs the pulp that the operation is nearly or quite painless.

PREPARATION OF ROOTS FOR FILLING.

After the complete extirpation of the pulp, the root canals will need but little further preparation for filling. For convenience the canals may be enlarged one-quarter to one-third of their length, but canals in roots of normal form and condition need never be enlarged, and are better filled without.

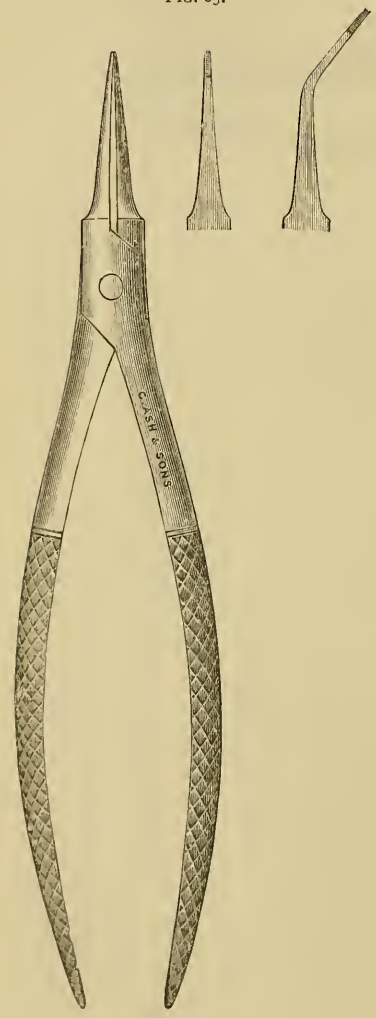
If the foramen is found to be large, so that an instrument may pass through, measure the length of the root with a fine hook broach passed through the foramen, and drawn back until the hook catches on the end of the root. Mark this length from the surface on the instrument by a small bit of rubber dam through which the instrument was previously passed. Remove the broach, then, with a drill a little larger than the foramen, the length being marked in the same manner, but a little less than the first, enlarge the canal to this extent, thus leaving a square shoulder near the foramen. (Fig. 84.)

Fig. 84.

Insure a healthy condition of the tooth and surrounding tissues.

If a broach or drill should be broken off in the root canal, an accident which occasionally occurs, the broken end may be removed, if the canal is large and accessible, by passing another broach at one side and beyond it and drawing it out, or it may be grasped and drawn out by the canal pliers shown in Fig. 85. In many instances it will be found impossible to remove it by any mechanical means. In such cases fill the canal with strong tincture of iodine, seal the cavity with gum sandarac on cotton, and in a few days the iron will be found reduced to an oxide, when it may be removed by breaking up or drilling.

Fig. 85.



FILLING ROOTS OF TEETH.

Roots may be filled with gold, tin, gutta-percha or oxychloride of zinc.

Gold or tin foil, rolled into points having about the size and form of the canal, one-fourth to one-third of an inch in length, may be used to fill the apex of the root, being carried to place by a fine canal plugger and gently but firmly malleted. Continue until the upper third of the root is solidly filled.

Gutta-percha is used dissolved in chloroform and carried up, by means of cotton wound on a broach, until the root is

filled; but this remains soft and porous. A better method of using gutta-percha is to roll it, while warm, into properly-shaped points, as directed for gold, and, when cold, dip in chloroform and press or mallet to place.

Oxychloride of Zinc.—Mix this thin like cream, and, with a fine broach wound with cotton and dipped in the cement, carry it to the apex of the root; repeat the process, and gradually the whole root may be filled.

Oxyphosphate of zinc is an excellent material for filling roots and pulp chambers, but its sticky quality renders it difficult to carry it to the apex of a small, tortuous canal, and for the apical portion it is better to use some other material.

To fill a canal with an open foramen, prepare a cylinder of gold or gutta-percha, with square end the size of the canal, which has been previously enlarged nearly to the apex, and press or mallet gently to place, as before described, using as large a plugger as will pass up the canal.

Cotton, in a small thread saturated with oxychloride of zinc, is successfully used to fill root canals, and by many this is thought to be the best method.

The pulp chamber may in all cases be filled with cement.

BLEACHING DISCOLORED TEETH.

In bleaching teeth discolored from internal causes the essential feature of the process is the removal of the discolored dentine from the interior of the tooth and the filling of the cavity with light-colored oxychloride of zinc. To do this, drill through the palatal, lingual or grinding surface, if no cavity already exists, and with burs and excavators remove as much as is possible and safe of the discoloration, sometimes leaving only the enamel walls. Fill with oxychloride of zinc, and allow it to harden; then fill the orifice of the cavity with permanent filling.

Chemical reagents may be used in the cavity for bleaching.

"Fill the cavity with chlorinated lime; then wet this with

water 8 parts, acetic acid 1 part. This liberates chlorine, which bleaches the tooth. The orifice of the cavity should be stopped with cotton or wax, to confine the liberated gas.

"This need not remain longer than fifteen minutes, when another application may be made, if needed. Two or three applications will accomplish all that should be expected." *

"Another method is: Take 100 grains sodium sulphite and 70 grains boracic acid, both carefully dried and ground together, in a warm, dry mortar, to a fine powder. Place some of this powder in the cavity, add a drop of water, and stop the orifice temporarily; or take of sodium sulphite 100 grains, boric oxide 55 grains. Prepare and use as above described."

"Another method: Wash the cavity repeatedly with peroxide of hydrogen, dry thoroughly with hot air. Place a small quantity of aluminum chloride in the cavity, and wet it with peroxide of hydrogen. Allow this to remain five minutes, and then wash out the cavity with water." †

"Another: Wash the cavity with a solution of permanganate of potash; then use alternately a four per cent. solution of sulphuric acid and Labarraque's solution. Repeat for a few minutes; then dry the cavity, and it is ready for the filling." ‡

TREATMENT OF FIRST MOLARS.

The first molars are the largest teeth in the mouth and have the largest roots. If of good quality, they are the strongest teeth, but they are frequently faulty in structure or imperfectly developed. Often there are small pits or holes in the enamel and fissures on the grinding surface, leaving the dentine exposed to decay. Sometimes they are so poor that decay begins immediately after their eruption, and they fail entirely

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* Dr. Kirk. "American System of Dentistry."
† Dr. Harlan. "American System of Dentistry."
‡ Dr. Regester. "American System of Dentistry."

before the patient is aware of danger. Being erupted at the age of six years, they are often mistaken for temporary teeth, and are neglected on this account.

The treatment of these teeth should depend upon several considerations:—

First. The quality of the teeth.

Second. The probability of saving them permanently or temporarily until the eruption of the second molars, without an unreasonable amount of attention.

If the teeth are well developed and of good structure, we may expect to save them as well as any teeth in the mouth; but if poor, it may be unreasonable to attempt to retain them beyond the time of the eruption of the second molars.

The arguments in favor of saving these teeth are:—

First. The avoidance of the shock of extraction.

Second. The greater certainty of the full development of the jaw, and a more perfectly normal occlusion of the teeth.

Third. Their great value as masticators, especially until the eruption of the bicuspids and second molars.

The arguments in favor of early extraction are:—

First. Much severe experience in the operating chair is spared to the patient under the stress of having teeth filled at an age when such operations are not well borne and the courage is often broken, in consequence of which much injury comes to the other teeth from neglect.

Second. Room is gained for the anterior teeth to become somewhat separated, as they usually will, and so be rendered less liable to caries.

Third. Room is afforded for the more perfect development of the second and third molars.

Fourth. If the teeth are irregular from crowding, room is given for self-regulation.

Unless the quality of these teeth is so poor as to render it impracticable, they should be preserved until just before the time for the eruption of the second molars, so that these may come forward and take the place of those extracted. This

should be done, even if it necessitates the removal of the pulp and the filling of the root canals.

The plastic fillings should be used in these teeth for their preservation until it is fully determined whether they are to be permanently saved or lost, and until the patient is well able to bear the operations required for the insertion of permanent fillings.

Third Molars.—These teeth are valuable to the patient when they are of good quality, in proper position and have sufficient room in the jaw.

The upper third molar is frequently out of position, projecting toward the cheek and proving a source of constant irritation. In such cases it should be extracted.

The lower third molar frequently fails of complete eruption from lack of room at the angle of the jaw, and in consequence of this the overlying tissue is kept in a state of constant irritation, and often serious inflammations result. In these cases, if either the first or the second molar is much decayed and the third molar is of good quality, extract the first or second, and thus allow the third to move forward and relieve the pressure, otherwise extract the third molar.

TREATMENT OF THE TEMPORARY TEETH.

The treatment of the temporary teeth should be governed by the same general principles as that of the permanent teeth. If decayed, they should be filled and preserved, if possible, until they are shed by the process of absorption.

Their preservation is desirable for the following considerations:—

First.—Their service in mastication.

Second.—The prevention of disfigurement.

Third.—The greater certainty of thus insuring a more perfect development of the permanent set.

Fourth.—The prevention of suffering from toothache and from extraction before the roots are absorbed.

Cleanliness is essential to the welfare of these teeth, and children should be encouraged to use the brush at as early an age as they are capable, and previous to this time the nurse or the mother may use it for the child, to the great advantage of the teeth.

It is unwise to attempt to perform as thorough operations upon the temporary teeth as upon the permanent, and it is seldom possible, as the teeth are friable and their support in the jaw weak, and patients at this tender age cannot well bear the discomfort of dental operations.

Plastic fillings only should be used for these cases. For the anterior teeth oxyphosphate of zinc or gutta-percha is best, and for the molars amalgam serves an excellent purpose when the cavity is well formed; but if very shallow, or the pulp is nearly exposed, oxyphosphate is better.

If a pulp is exposed and painful, quiet with sedatives, devitalize with tannic acid and creasote, remove as much of the pulp as possible and, placing a piece of small pin through the cavity into the pulp chamber, fill the cavity around the pin, and when the filling is finished, remove the pin, leaving the hole as a vent from the pulp chamber; or fill the cavity and then drill a small hole just beneath the margin of the gum into the pulp cavity for a vent. • It is usually quite impracticable to fill the roots of these teeth.

Exposed pulps in these teeth, if not painful, may be covered with tannic acid and glycerine on a soft pellet of cotton, filling over this with cement without pressure. Thus treated, they will remain quiet for an indefinite time. This treatment is not applicable to permanent teeth.

It is good practice to dress off the distal surface of the second temporary molar to preserve the first permanent molar from decay. It is also wise, whenever practicable, to dress away the other proximal surfaces of the temporary molars and thus render them less liable to caries.

When abscess forms, it may often be necessary to remove a tooth for the relief of pain; but if the abscess has become

chronic and gives the patient little or no annoyance, the tooth may be allowed to remain until there are other indications for its removal.

HYPERCEMENTOSIS.

This affection of the teeth is *hypertrophy* of the *cementum*. It often produces great enlargement of the roots, rendering extraction difficult and occasionally impossible. It is more common near the apex of the root, but it may appear on any part of the cementum and assume a variety of forms.

The cause is obscure. It may result from local irritation of the pericementum, from want of occlusion or from syphilis.

Treatment.—No treatment is known that will cure it, and if productive of pain to the patient, extraction affords the only relief; but some think the administration of iodide of potassium may afford relief by producing resorption of bone to make room for the tumor.

PERICEMENTITIS.

Inflammation of the Pericementum is acute or chronic, according as it is recent or of long standing.

The symptoms in the earlier stages are sensitiveness to thermal changes, a feeling of uneasiness and of tension or fullness, with a desire to press the teeth together, this affording temporary relief. Soon the tooth seems longer than the others, and occlusion gives great pain. In the later stages the gums become red, tender, and swollen, and these latter symptoms are accompanied by dull, heavy pain, which may become very severe.

Acute Pericementitis may continue but a few hours, or it may take several days to run its course.

An attack of acute pericementitis is very likely to result in the chronic form. In such cases the tooth will suffer severe exacerbations of the disease from any slight cause, such as cold or injury, with periods of rest of varying length between, during which the tooth seems entirely well.

Acute pericementitis may terminate by resolution and perfect recovery follow, or it may assume a chronic form and continue indefinitely, but if unchecked in its course its termination will be alveolar abscess.

Pericementitis is caused usually by an inflamed or otherwise diseased or disorganized pulp. It may be caused also by a blow, hard biting or other violence, by calculus or other foreign substance about the neck of the tooth, or it may result from the systemic effects of mercury.

Treatment.—Remove the cause and then protect the tooth from occlusion by a cap of gutta-percha over some other tooth, and thus give it rest.

If the pulp is diseased restore it to health or devitalize and remove it. If it is disorganized, remove it, and thoroughly disinfect the cavity and canals. Remove all calculus or other foreign substance from the neck and roots of the tooth. With a small pellet of cotton wound upon the end of a wood toothpick, or with a camel's-hair brush, paint upon the gum tincture of iodine, or equal parts tincture of iodine and tincture of aconite root, or dry the gum and apply capsicum plasters or bags, or cantharidal collodion.

Give saline cathartic, as citrate or sulphate of magnesia.

The same treatment applies to chronic pericementitis, and it should be repeated as occasion requires.

Phagedenic Pericementitis.—The form of pericementitis which commences at the margin of the gum and progresses downward upon the root of the tooth has long been recognized, but special attention was called to the disease and its treatment by the late Dr. Riggs, and it has since been known as Riggs' Disease. It is also known as pyorrhœa alveolaris, but the term phagedenic pericementitis has been more recently proposed, and as it is received with favor and is expressive of a condition which obtains throughout the entire course of the disease, it is adopted in this place.

It usually begins on a single surface of the tooth, or upon a small spot only, but it may, in the early stages, affect the tissues

throughout the entire circumference of the tooth. It may also, in the beginning be confined to a single tooth, attacking others consecutively, or it may affect several or all of the teeth in the mouth at the same time.

When the inflammation starts from a single spot it forms a pocket under the gum by the destruction of the pericementum and alveolar wall. These pockets may reach to the apex of the roots and include only a small portion of the circumference.

When the whole circumference is involved at first the margins of the gum and alveolar walls gradually waste away, leaving the neck and root of the tooth exposed as the disease progresses, until the connection of the tooth with the jaw is destroyed, and the tooth falls out for want of support.

Often a single surface, the buccal or lingual, may be exposed to the apex and the remaining parts continue comparatively healthy.

At the beginning of the disease there is increased redness, accompanied by a thickening of the margin of the gums, their color becomes purplish, the gum loosens from the neck of the tooth, and beneath it is an accumulation of serum and saliva, mucus and cast-off epithelial scales. This accumulation is irritating, and hence its presence hastens the progress of the disease. At this stage the alveolar walls begin to be affected and to waste away, and necrosis may occur to some extent. In the more advanced stage of the disease pus is formed, and if pressure be applied to the gum the pus may be seen to ooze out around the neck of the tooth. In some cases in which many teeth are severely affected the discharge of blood and pus is so great as to weaken the patient and seriously impair the general health.

The disease may be the result of local irritation or of systemic conditions, the local irritation being produced, in most cases, by salivary calculus, but any foreign substance, as a ligature or rubber band around the tooth, or a bristle from the tooth brush, may produce it.

After the disease has made some progress the deposit of serumal calculus increases its severity and extent.

In some cases it occurs and goes on to the destruction of the pericementum and alveolar process without the presence of calculus or any other irritant so far as can be observed. Syphilis seems to induce this form of the disease.

Treatment.— The essential treatment is surgical, and consists in the entire removal of all calcareous or other deposits from the teeth, as described on page 54, and of any diseased portion of the alveolar process, and a thorough removal of all débris from beneath the gum. In cases in which calcareous deposits are absent the alveolar wall is affected and the surgical treatment should be directed to the removal of the diseased portion. The treatment should be repeated at intervals of one week until the disease is cured or it becomes evident that further improvement is hopeless.

Medicinal agents locally applied exert a beneficial influence and hasten the cure. These are most conveniently and effectively applied with a syringe having a long, fine tube, which may be passed down by the side of the root and the medicine applied at the seat of the disease.

Usually, mild remedies are sufficient, but sometimes caustics, such as the sulphate, chloride or iodide of zinc, nitrate of silver or deliquesced carbolic acid may be required. Aromatic sulphuric acid or tincture of iodine may be used, full strength, every three or four days, together with peroxide of hydrogen daily. The first application of carbolic acid may be full strength, followed by washings with a five per cent. solution of the same, and peroxide of hydrogen daily.

Astringents are also valuable. Sulphate of zinc, five grains to the ounce of water, or chloride of zinc, three grains, or tannic or gallic acid, three grains to the ounce, may be used daily or alternated with the above-mentioned disinfectants and caustics.

If patients find it impracticable or very inconvenient to call daily the disease may, in most cases, be treated successfully if the applications are made at longer intervals.

NECROSIS OF TEETH.

Necrosis, as applied to a tooth, means death of the entire organ, both pulp and pericementum. It rarely occurs.

It is caused by dead pulp, violence, long use of mercury, calcular deposit, exhausting diseases, or impaired nutrition.

Signs.—Tooth much discolored, loose, with little or no vascular connection.

Treatment.—Removal.

REPLANTATION OF TEETH.

Replantation of teeth is a practicable operation, and a very useful one in cases of persistent chronic inflammation or abscess, or of accidental removal.

To perform the operation, extract the tooth with care and wash it in tepid water, scrape off the thickened pericementum or abscess, and file or cut off a little from the end of the root; enlarge the foramen from the outside with a conical reamer, fill with gold and polish. If not already treated, remove the decay from the cavity and the pulp from the pulp canal, fill the canal and the cavity and finish.

Syringe the socket clean with warm salt water, and be sure that all blood clots are removed and that bleeding has ceased. Bathe the tooth in solution of bichloride of mercury $\frac{1}{2000}$, reinsert in the socket and carry firmly to place, allowing the patient to bite firmly together to insure proper occlusion. Secure the tooth with silk ligatures. If it be an anterior tooth, tie the silk to the necks of the adjoining teeth, and around the replanted tooth above the cingule.

If it be a bicuspid, tie a ligature around the neck of each of the adjoining teeth and over the crown between the cusps of the replanted tooth.

The molar teeth can seldom be replanted with success.

The tooth may be kept out of its socket several hours, but the shorter the time the better will be the chances of success.

Transplantation of teeth may be performed when two

patients are found at the same time, one needing a tooth supplied, and another healthy patient having a suitable tooth which he is willing to sacrifice. The same directions should be observed as in replantation.

Extracted teeth may also be prepared as for replanting, and kept indefinitely in carbolic acid water and used as occasion may require.

Teeth have been successfully transplanted after remaining in this solution several months.

Teeth may be transplanted into artificial sockets, a hole of proper size being cut through the gum, and a socket of proper size and shape being formed in the bone with drill and burs and the tooth inserted as in other cases. Many cases have proved temporarily successful, but the value of the operation is by no means established.

ALVEOLAR ABSCESS.

The term alveolar, as applied to abscess, indicates its location within the alveolar walls, and with rare exception it is at the apex of the root of the tooth.

Alveolar abscess is either acute or chronic.

Acute abscess is the result of active inflammation, and usually runs its course in from three to six days. As pus is formed absorption of tissue takes place toward the point of least resistance. This is called pointing. When pus is discharged the abscess may heal at once. When acute abscess fails to heal, pus continues to form, a fistula becomes established and the abscess becomes chronic.

Occasionally acute abscess is cured spontaneously by resorption of the pus without pointing, or the formation of a sinus.

Sometimes the pus is not absorbed, but remains and the parts become tumefied, forming what is called cold, or blind abscess, which is also chronic. Alevolar abscess usually points through the buccal or labial tissue nearly opposite the

offending root, sometimes through the palatal or lingual surface of the jaws, and occasionally into the antrum or into the nares, the discharge dropping down behind the palate, or on the outer surface, as under the chin or behind the angle of the jaw. In one case pus gravitated around the hyoid bone, causing glossitis and death. Pus from abscess of the superior third molar may pass forward into the frontal region and discharge from beneath the orbit, or at the inner or the outer canthus, or, passing down beneath the deep cervical fascia, discharge at the nucha, or well down on the scapula. From the inferior third molar it may discharge low down on the chest, even to the fifth rib, following the sterno-mastoid and pectoral muscles. A common channel for the discharge of pus is through the canal of the root, and in such cases the abscess must be entirely cured before the root is filled.

Alveolar abscess is a sequence of pericementitis, for the causes of which see page 107.

The symptoms of acute abscess are extreme soreness of the tooth, chill, fever, throbbing pain, and in the later stages swelling and fluctuation. The pain of acute abscess is very severe until the pus has penetrated the bone.

The principal sign of chronic abscess is the presence of the sinus and the discharge of pus. Necrosis occasionally results, and the symptoms above described assume an aggravated form.

Symptoms of cold or blind abscess are tumefaction of its parts, and characteristic thinning of the walls, which often yield readily to pressure of the finger.

Treatment of Alveolar Abscess.—To abort an abscess. If the root of the tooth has not been cleansed and filled, open freely into the root canal, and allow it to remain open until the pus or other products of inflammation have passed off and the condition is relieved.

Apply a capsicum bag or plaster, or strong tincture of iodine, or equal parts tincture of iodine and tincture of aconite, to the gum over the affected parts, or saturate a piece of cotton

with chloroform, place it on the gum, cover with a piece of rubber dam and hold it in place with the finger two or three minutes. Bloodletting will also be of use, and it may be effected by scarification or by leeches. Give quinine and Dover's powder at night, and a saline cathartic, sufficient to act quickly, in the morning. If pain becomes unbearable, give an opiate.

If the abscess is not cured in this early stage, its pointing may be hastened by continued application of capsicum bags or plasters, and its course favorably modified by fomentations applied to the face, and opiates to relieve severe pain; but if any tendency to point on the outside of the face is shown, fomentations should be avoided.

If the pulp canals have previously been filled, it is in some cases practicable to remove the filling from the root, or drill

Fig. 86.

through it, and thus gain relief, as before described; but usually the abscess will complete its course and point upon the gum.

When pointing shows upon the gum, the lancet (Fig. 86) should be used to evacuate the pus.

Oftentimes, if the location of the abscess can be determined, relief may be early obtained by drilling the alveolar wall with an ordinary drill in the engine or the hand, first cutting the gum with a circular knife in the engine. The knife should be dipped in glycerine or oil to prevent adhesion of the tissue. A circular piece of the soft tissue being thus removed, immediate healing is prevented without further treatment.

At a subsequent sitting, cleanse and disinfect the root canals, and stop lightly with cotton moistened with some disinfectant. The following is excellent:—

Carbolic acid cryst.	℥j	
Iodine	℥j	
Alcohol	℥ij.	M.*

Others may be substituted. Cover this with cotton and sandarac, or gutta-percha and wax, and allow it to remain one or two days; then remove and repeat the dressing, and stop with cotton as before, but more tightly. Repeat this treatment till the tooth will bear to be stopped tight. This is proof that the tooth is in proper condition for filling.

The more simple forms of chronic abscess will be cured by the same course of treatment of the root canals, especially those which have no fistula established, but are discharging through the root canal.

Treatment of Chronic Abscess with Fistulous Opening.— Cleanse and disinfect the root canals, and as soon as they can be made thoroughly dry, fill permanently. This may be at the first or at a subsequent sitting. The escape of moisture through the foramen may render it impossible to make the root canals dry until the abscess has partially healed. In the meantime, the canals should be kept tightly filled with cotton, and the opening covered with sandarac or gutta-percha. In most cases this treatment is sufficient to cure the abscess.

If the fistula persists after treatment for one or two weeks, and the root has not been permanently stopped, fill an abscess syringe, having a long, fine point, with an injecting fluid, such as carbolic acid water, sulphuric ether, peroxide of hydrogen, or ten per cent. solution of chloride of zinc.

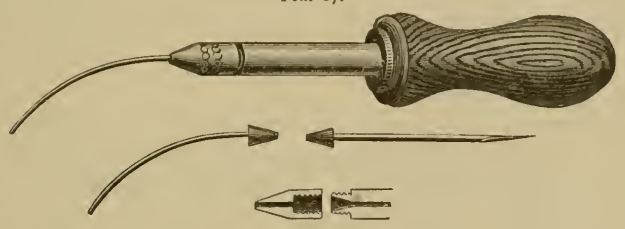
Place the point of the syringe in the root canal, seal the cavity with gutta-percha, and inject the fluid, forcing it, if possible, through the root, along the fistulous tract, until it escapes at the opening on the gum. Refill the root temporarily, and if at the end of one week the fistula is not healed, repeat the treatment, and if after two or three repetitions, with the same interval between, the abscess is not cured, there is

* Dr. Litch.

reason to suspect some roughness or deposit upon the root. Fill the root canal permanently, then enlarge the fistula with a sponge tent or by incision, or, if the fistula is not direct, make a new opening, for which the circular knife and trephine are excellent. Remove any deposit or roughness from the root, wash the parts and leave the case to heal.

If the discharge from an abscess is septic, strong antiseptics are needed. The whole abscess should be injected with a ninety-five per cent. solution of carbolic acid, strong tincture of iodine, or ethereal solution of iodoform. Repeat within four days, and follow with the milder treatment described above. Such cases will require considerable time to recover,

Fig. 87.



and constant care will be requisite to keep the parts in good condition.

If the case is complicated by necrosis, time must be given for exfoliation, after which the dead bone is to be removed and the wound treated with mild applications. Support the soft parts in place by sutures, if necessary, until healed.

Intractable abscess may sometimes be cured by amputation and removal of a part or the whole of a root of a tooth.

A hypodermic syringe, or one specially designed for the purpose, may be used. Fig. 87 shows one recently devised by Dr. Dunn, which is simple and effective.

EXTRACTING TEETH.

The operation of extracting teeth requires skill, judgment and experience, and accurate anatomical knowledge of the parts. It is one of the most difficult and uncertain operations in surgery.

The improved instruments of the present time render the operation much less difficult and dangerous than formerly. The demand for the operation does not arise from fancy, fashion or caprice, but from dire necessity, and few escape it.

Examine the mouth carefully, to be sure which is the offending tooth. The patient's knowledge and judgment must not be depended upon, as the pain may be referred to a distant tooth, even in the opposite jaw.

Some conditions may forbid extraction, as heart disease so far advanced that the shock might prove fatal, a pronounced hemorrhagic diathesis, or active constitutional syphilis. Pregnancy does not forbid.

The operation should not be hurried. Move no faster than the eye can carefully follow, and the mind fully comprehend, each movement of hand and instrument. With care a great amount of force may be applied safely, but a small force unskillfully applied may do injury, especially by breaking the tooth or bruising and lacerating the gum. The amount of force required can be only roughly estimated before the operation. The operator must feel his way, and apply force in amount and direction as it is needed.

Characteristics of teeth which are difficult to extract:—

1. Those with short, thick crowns.
2. Incisors that occlude and are thick and strong.
3. Teeth which are particularly regular and in close contact indicate conditions which render extraction difficult.
4. Teeth with small necks and long roots in dense alveolar walls.
5. Teeth affected with hypercementosis.
6. The upper cuspids are uniformly hard to extract.

Conditions which render extraction peculiarly painful are hyperæsthesia of the parts, neuralgia of the fifth nerve inflammation of the surrounding tissues.

Indications for Extraction.

1. Persistent abscess, hypercementosis, or other painful or diseased conditions that cannot be otherwise cured.

2. When needed to prevent or correct irregularity.

3. When the temporary obstruct the eruption of the permanent teeth ; but do not remove adjoining teeth simply to give room.

4. Temporary teeth may need to be removed early to relieve irritation or inflammation.

5. Need of preparing the mouth for artificial denture.

Since the forceps have become so much improved in the form, size and adaptability of the beaks gum-lancing has

FIG. 88.

fallen into disuse, and at present few operators advise it. Occasionally the operation may be of service to prevent laceration of the thick and adherent gum around a tooth standing alone. A form of lancet well adapted to the purpose is shown in Fig. 88. Carry the lancet down to the alveolus and pass it around the tooth, severing as completely as possible the adherent gum.

In the case of roots where it is necessary to grasp and cut through a portion of the alveolar process, an incision may be made in a line with the axis of the tooth and the gum freed from the alveolus each way from the line. This may be done with two downward strokes of the lancet.

The number of teeth that may be extracted at one sitting varies greatly, according to the mental and physical condition

of the patient. In favorable conditions fifteen, twenty or even more teeth may be removed without untoward results, while in cases of extreme fear or other mental disturbance, or of physical debility, one may be all that it will be prudent to extract at one sitting. A tendency to epilepsy may render a patient less able to bear the shock of the operation.

Pregnancy should be considered, and no more should be done than is necessary to give relief.

In great debility, stimulants may be given before the operation. In mental irritability, sedatives may serve a better purpose.

It should be remembered that the sensitiveness of the fifth nerve is such that injury to any of its branches has a peculiarly depressing effect upon the heart's action.

Accidents.

1. Breaking teeth.
2. Fracture of alveolus.
3. Laceration of gum.
4. Removal of wrong tooth.
5. Dislocation of inferior maxilla.
6. Hemorrhage.
7. Syncope.
8. Dropping of the extracted tooth into the patient's throat.
9. Gangrene of the socket.

The fracture of teeth and alveolus can, in most instances, be avoided by the exercise of proper care and skill, though sometimes the resistance of the alveolar walls embracing divergent or malformed roots renders the removal of the tooth without fracture impossible. The breaking of a tooth often proves to be a serious accident. Severe inflammation and great suffering follow.

If a tooth is fractured and the removal of the remaining portion is impracticable or unadvisable owing to the injury that would necessarily be inflicted in its removal, and the pulp remains exposed, pain may be allayed by the use of creasote, after which it may be devitalized by the application of arsenical

paste. This may be readily held in position by a loose pellet of cotton saturated with sandarac, the latter forming a cap which stays firmly in place.

Laceration of the gum is likely to occur only when undue haste is exercised, hence, due deliberation and care will prevent it. If, during the operation, the gum is found to adhere to the tooth, stop the operation and sever it with lancet or scissors, and then complete the extraction.

The removal of a wrong tooth is inexcusable under all circumstances, and is wholly due to carelessness in applying the instrument, or lack of observation in examination.

Dislocation of the jaw is caused by spasmodic action of the depressor muscles, and may be prevented by properly supporting the jaw with the left hand during the operation. If this does occur, the dislocation may be reduced by standing in front of the patient, placing the thumbs upon the molar teeth of each side of the jaw and pressing downward and backward, at the same time elevating the chin with the fingers underneath. The operator must be ready to slip the thumbs outward, off the teeth, lest they be caught by the sudden closing of the jaw when it goes to place.

Syncope.—Fainting may occur during or subsequent to the operation. It usually results from terror, rarely from loss of blood. A dose of some stimulant given before the operation may prevent it. The best remedies are a horizontal or reclining position and plenty of air. A little cold water sprinkled on the face will hasten recovery.

Hemorrhage.—Arterial hemorrhage takes place from the severed dental arteries. Capillary hemorrhage is seen in the oozing of blood from the wounded surfaces of the gum.

Hemorrhage may be primary or secondary. Primary hemorrhage is that which immediately follows the operation.

Secondary hemorrhage takes place a few days after the operation and is the result of sloughing of the clot.

Arterial hemorrhage may be readily controlled by packing

the socket with cotton, dry or soaked in solution of alum, tannin or persulphate of iron.

To stop capillary hemorrhage, plug the socket, as before, filling it completely so as to press upon the wounded edges of the gum. Usually this will succeed. If the bleeding still persists, it may be necessary to bring pressure upon the surface, as by placing cotton dipped in solution of persulphate of iron or other styptic upon the gum and maintaining pressure with the fingers, or by gutta-percha or modeling composition warmed and molded to the part, or plaster sufficient in quantity to meet the occlusion of the opposite teeth or jaw.

The pressure should be moderately firm and steady and continued for some hours, until danger of a return of the bleeding is past. The cotton should be allowed to remain until expelled by the healing process. The treatment for primary and secondary hemorrhage is the same.

If the persulphate of iron in powder be applied to the bleeding surface and a pledget of cotton large enough to cover be held down firmly for ten or fifteen minutes, the cotton will remain adherent to the surface and effectually stop the bleeding in nearly every case.

Hot water is an excellent styptic.

Rest is all-important in the treatment of hemorrhage.

The actual cautery is a last resort and it will succeed when all else fails. The cautery should be of suitable size, not too large, heated not quite to redness, and held close to the bleeding surface, but not allowed to touch it, as the tissue would stick to the instrument and be torn away.

Gangrene of the socket results from degeneration and putrefaction of the clot formed after extraction. Granulation does not take place, pain and tenderness continue and the clot sloughs out leaving the bony walls of the socket exposed, putrescent and offensive.

A low or depressed condition of the system tends to produce this result.

For treatment, cleanse the parts carefully with warm water,

adding the solution of chlorinated soda as a disinfectant, and then apply pure deliquesced carbolic acid. This is thought by some to be a specific. One application is usually sufficient. Sulphurous acid is used successively, and nitric acid carefully applied will promote a healthy action.

INSTRUMENTS.

For extraction of the teeth the following instruments will be necessary, viz.: one upper molar forceps for either side, Fig. 89, one lower molar for either side, Fig. 90, one for upper bicuspids, cuspids, incisors and roots, Fig. 91, one for lower bicuspids, cuspids and incisors, Fig. 92, making four pairs. This seems to be the least number that will answer the purpose.

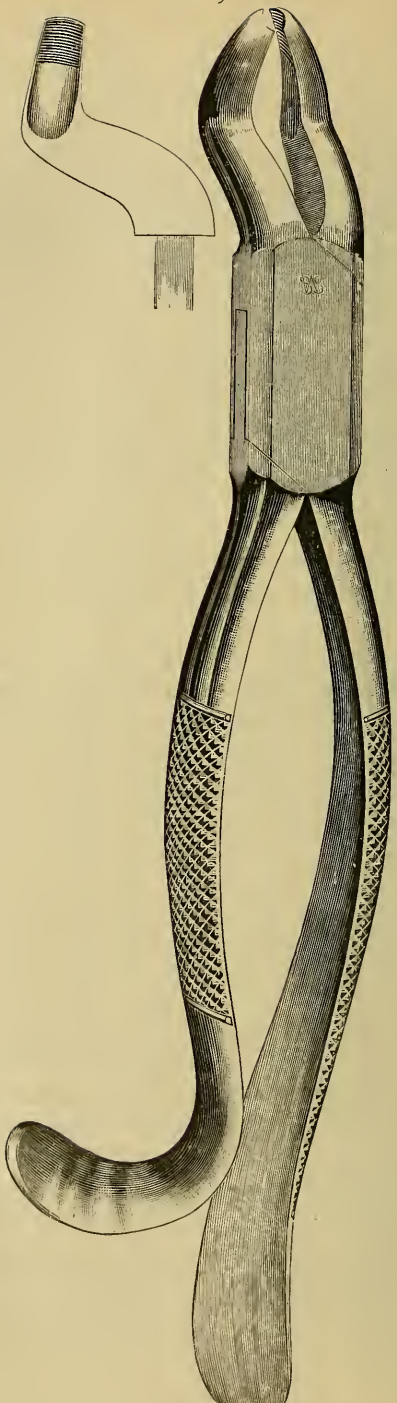
The set will be more complete with the following added, viz.: upper cowhorn, right and left, Figs. 93 and 94, lower molar cowhorn for either side, Fig. 95, Physic's forceps for lower third molars, Fig. 96, making eight pairs. To these may be added the key of Garengeot, a desirable form of which is shown in Fig. 97. The styles and forms of forceps manufactured are very numerous. A few more desirable forms will be added: one universal spicular root, Fig. 98, one extra narrow beak for crowded teeth, Fig. 99, and one pair alveolar forceps for upper, Fig. 100, and one for lower, roots, Fig. 101.

Many practitioners will desire peculiar patterns, which they can select or have made to order, but it is well for young practitioners to remember that skill in the use of a *few* instruments is better than the possession of many.

The forceps should be strong in all their parts, but not clumsy. The handles should be thick enough to prevent springing under the grasp of the hand.

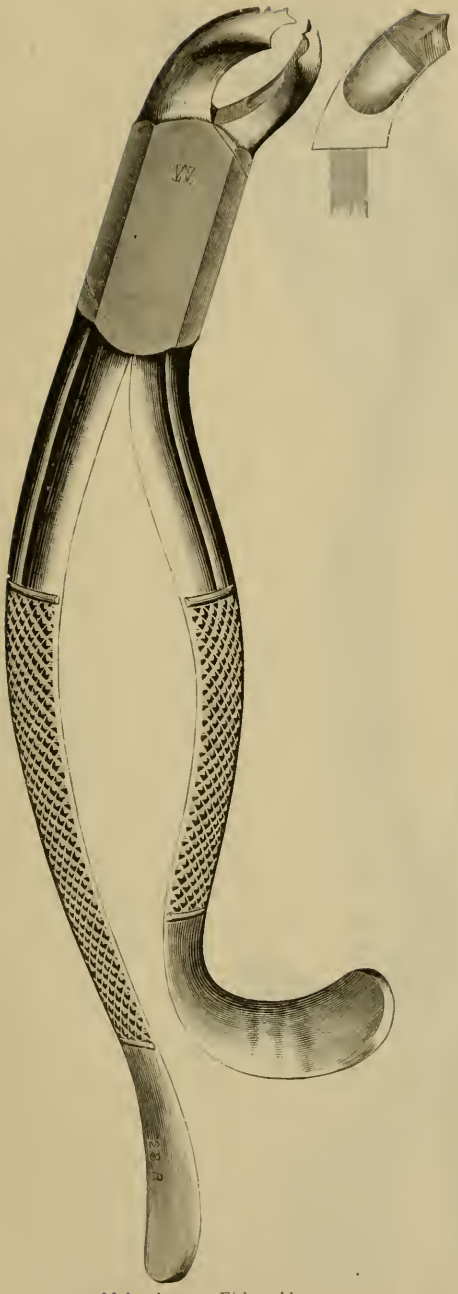
Forceps should be selected of such shape and size that they will conform to the hand that is to use them.

FIG. 89.



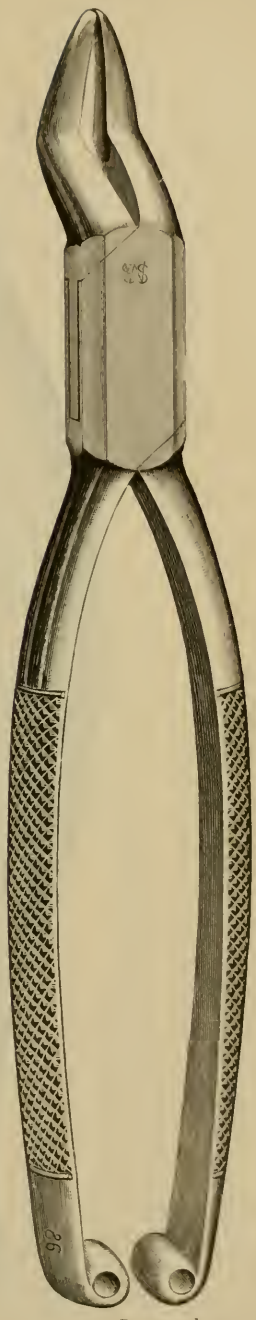
Molar, upper. Either side.

FIG. 90.



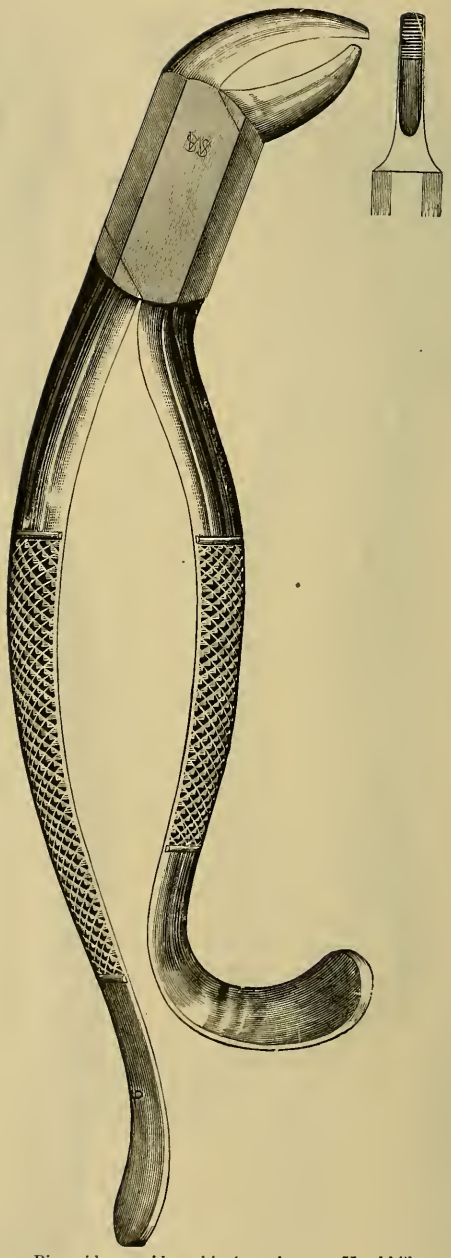
Molar, lower. Either side.

FIG. 91.



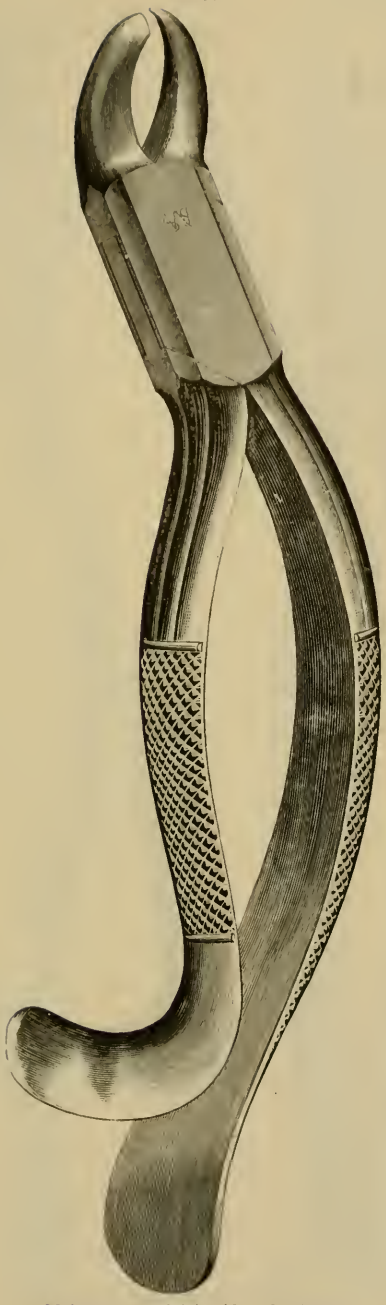
Root, upper. Bayonet shape.

FIG. 92.



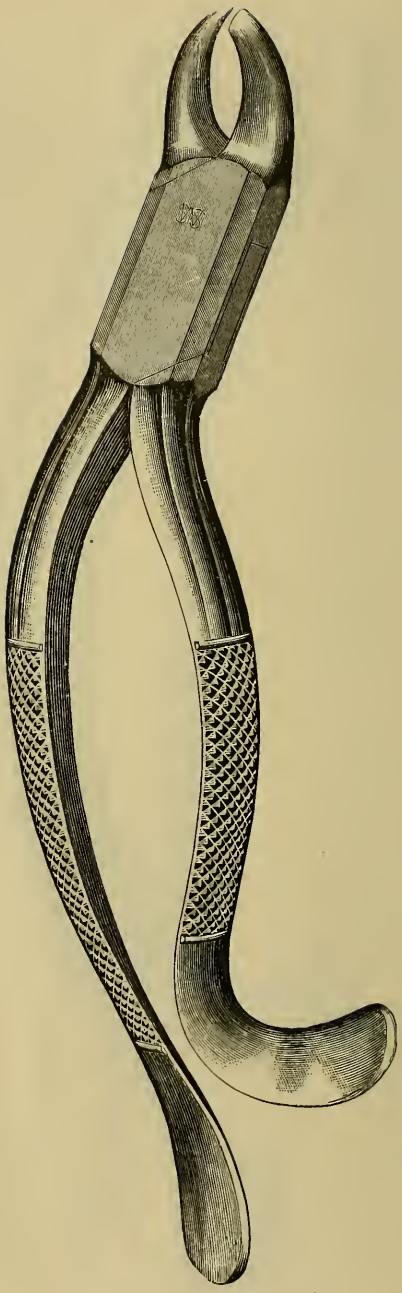
Bicuspids, cuspids and incisors, lower. Hawkbill.

Fig. 93.



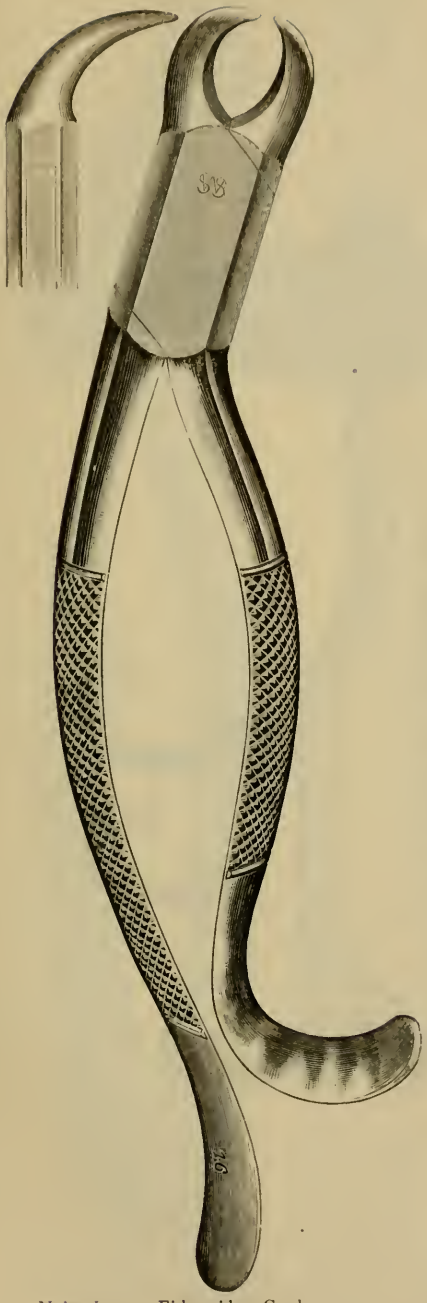
Molar, upper. Right side. Cowhorn.

Fig. 94.



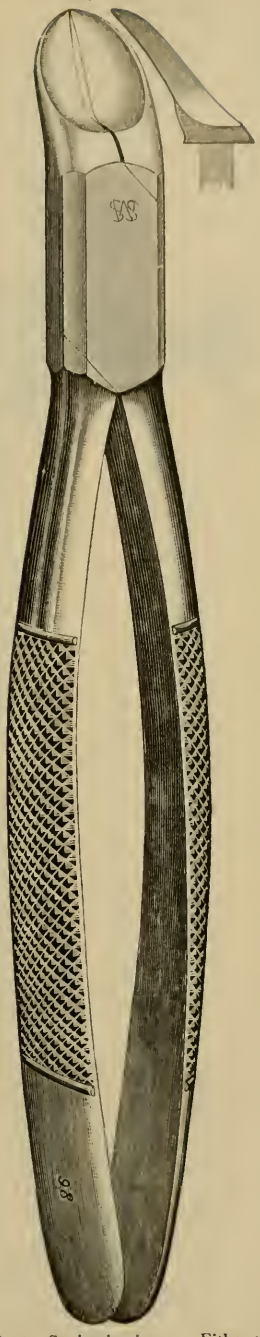
Molar, upper. Left side. Cowhorn.

Fig. 95.



Molar, lower. Either side. Cowhorn.

Fig. 96.



Dentes Sapientiæ, lower. Either side.

Fig. 97.

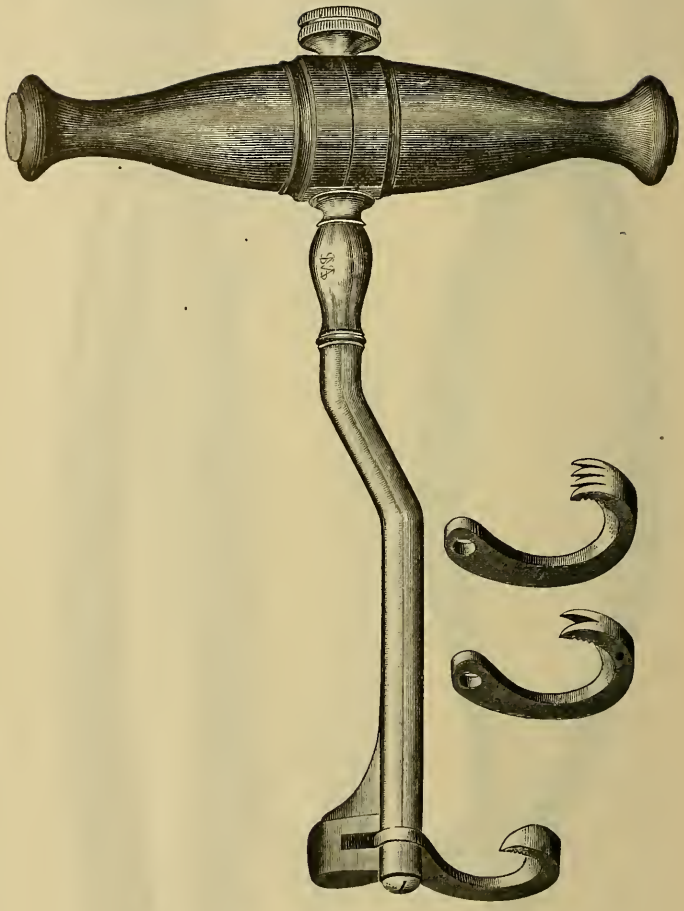
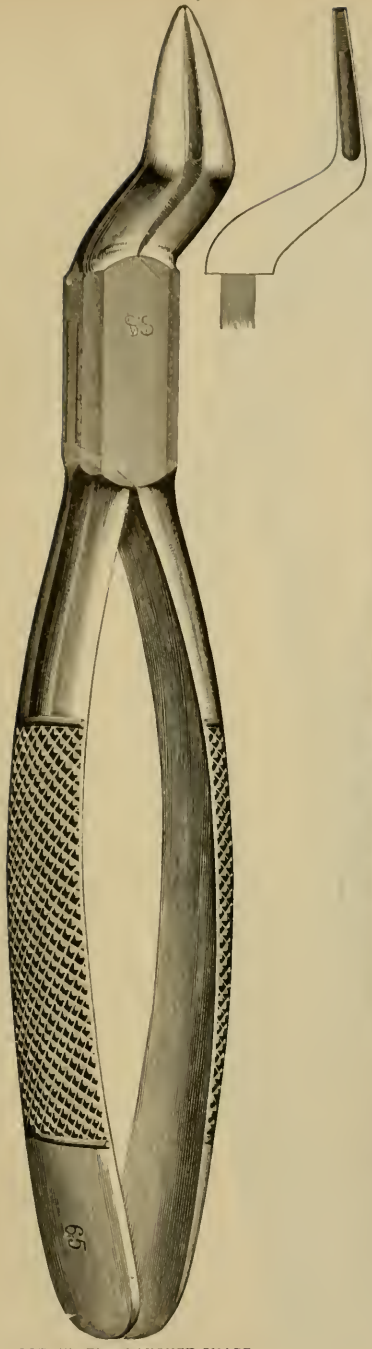
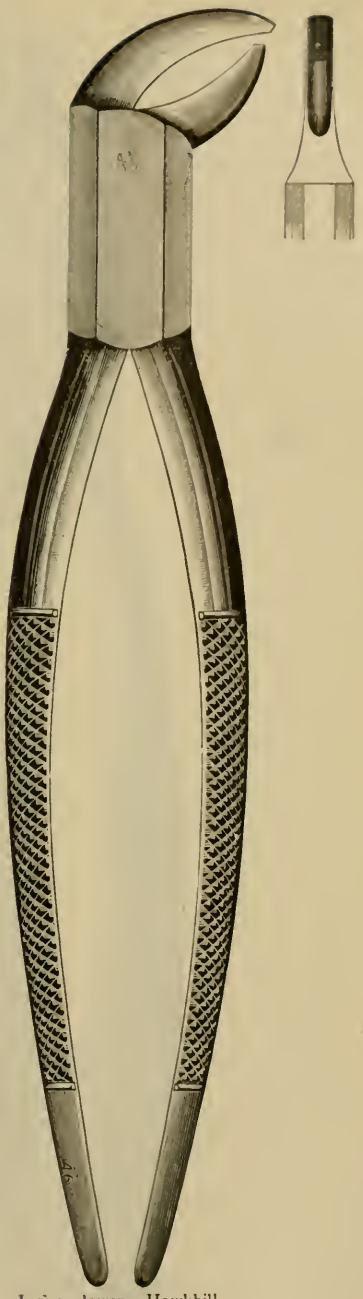


FIG. 98.



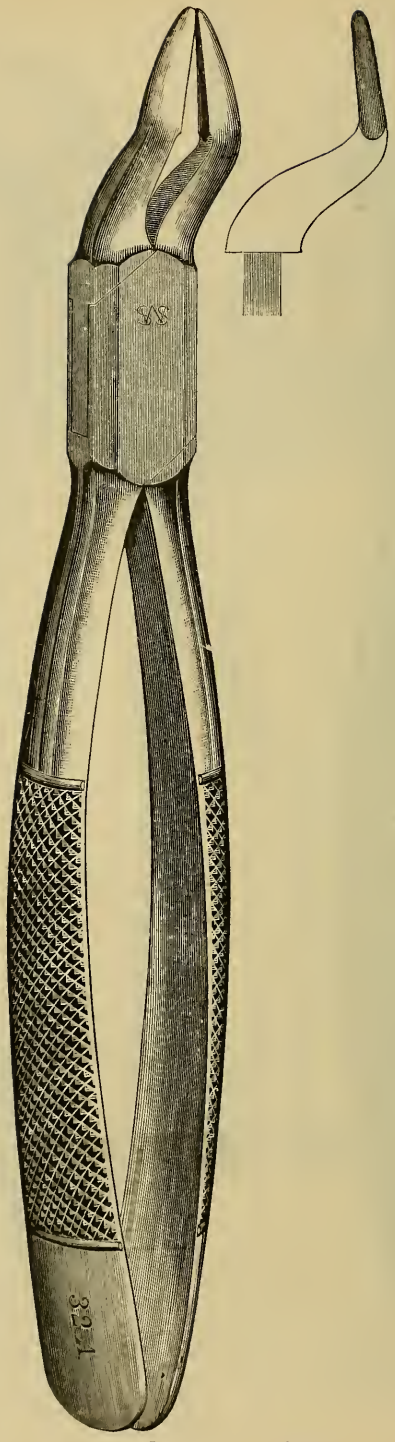
ROOT, UPPER. BAYONET SHAPE. SLENDER BEAKS.
For difficult roots in upper jaw, and roots of front teeth in lower jaw. Designed by Dr. B. F. Arrington.

FIG. 99.



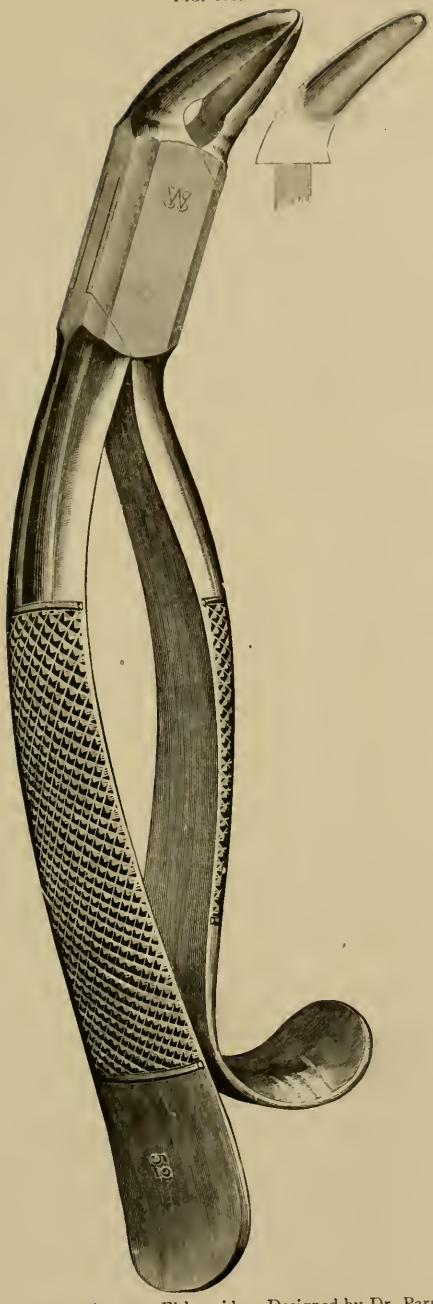
Incisor, lower. Hawkbill. (Crowded teeth.)

Fig. 100.



Alveolar. Bayonet shape. Small.

FIG. 101.



Alveolar, lower. Either side. Designed by Dr. Parmly.

Position of Patient and Operator.—For extracting, a chair the height of an ordinary easy chair is best. It should be firm and strong, with an ample head-rest, and somewhat inclined backward.

To extract the left upper bicuspids and molars, the operator should stand at the right and a little in front of the patient. Place the little finger and ulnar side of the left hand across the forehead; with the forefinger in the mouth distend the cheek, and with the thumb depress the lower lip. This will expose the teeth fully to view. Apply the forceps and extract as directed.

To extract the right upper bicuspids and molars, stand at the right of the patient; place the ulnar portion of the palm of the left hand upon the right side of the forehead, and with the forefinger distend the cheek opposite the teeth; with the second finger depress the lower lip, apply the forceps as directed and extract the tooth.

To extract the six anterior teeth of the upper jaw, stand at the right, and with the left hand hold the patient's head firmly against the side. With the forefinger elevate the upper lip, and with the second guard the lower. This will expose the teeth and the instrument may be readily applied.

To extract the lower molars and bicuspids of the right side, stand directly behind the patient, support the chin in the palm of the left hand, with the forefinger distend the cheek, and with the thumb depress the tongue. Apply the forceps and extract.

To extract the left lower molars and bicuspids, still standing behind the patient, place the palm of the hand against the side of the face, supporting the lower jaw with the third and fourth fingers, distend the cheek with the first finger, and depress the lower lip with the second, when the teeth may be clearly seen and the forceps applied. The left lower bicuspids may often be successfully extracted with the operator facing the patient.

To extract the lower incisors and cuspids, stand at the

right, pass the left hand under the patient's chin, support the lower jaw with the fingers, depress the lower lip with the forefinger, and the tongue with the thumb.

To extract the right lower bicuspids with the key, stand in front and facing the patient. For applying the key in all other cases, stand somewhat behind the patient, with the first and second fingers distend the lips and cheek and apply the instrument, guiding the hook with the finger.

To extract a tooth with the forceps, pass the beaks well under the gum, against the border of the alveolus, and grasp the tooth firmly; then make moderate traction, together with an outward and inward movement, mostly outward, until its connection with the jaw is broken, when it may be removed. Avoid grasping the teeth too hard, as excessive pressure is liable to break them.

In many operations we are more successful by applying a pushing force combined with other movements until the tooth is loosened. This is applicable to the upper incisors, and especially to the bicuspids. In extracting the upper central incisors, a rotating movement is especially applicable. Traction should seldom be made until the tooth is loosened.

In the case of the cuspids, the outward movement must be mainly depended upon, as the flattened form of the root renders rotation impossible. The greater size and length of the roots of these teeth, together with the flattened form, make them much more difficult to extract than either the incisors or bicuspids. It is sometimes necessary to pass the beak of the forceps well up on the alveolus and cut it through before the tooth can be made to yield.

In extraction of the upper bicuspids, press the forceps hard up against the alveolus, at the same time moving the hand outward and inward till the tooth gives way, when it may be removed by a direct pull.

In extracting the first and second upper molars, the same directions are applicable as for the bicuspids, whether the plain or cowhorn forceps is used. The use of the cowhorn

forceps necessitates a less amount of force than the plain beak, as the cowhorn weakens the alveolar wall by breaking down its edge, and by passing into the bifurcation of the buccal roots acts as a wedge, thus aiding in the removal.

The upper third molar will almost invariably yield to a simple outward movement.

The lower incisors offer no special difficulties in extracting. The outward and inward movement will loosen them, and they may be readily removed.

In extracting the lower cuspids both the lateral and rotary movements may be used, and as the roots are both large and long, the operation must be deliberately performed to give time for the parts to yield.

The same directions are applicable to the lower bicuspids, but the roots being shorter and nearly round renders their removal somewhat less difficult.

The first and second lower molars may be extracted with the plain-beaked or the cowhorn forceps, but to these the latter is particularly applicable, as the cowhorns passing in at the bifurcation of the roots act as wedges, and frequently the simple closing of the beaks will lift the tooth from its socket.

When the roots of the lower third molar curve backward, forming a hook under the ramus of the jaw, as is often the case, it is impossible to remove them by direct force as applied to the first and second molars. To meet this condition the Physick forceps (Fig. 96, p. 127) was constructed. This is used by closing the wedge-shaped beaks between the third and second molars, then, using the second molar as a fulcrum, the handles are depressed and the tooth started from its socket (*is unhooked*). If the tooth be then grasped with the double cowhorn forceps it may be easily removed, as the points of the beaks act as pivots on which the tooth may turn and follow in its removal the natural curve of the root. In this manner teeth may be removed without difficulty whose roots form perfect hooks, which it would be impossible to remove by any other method. In most cases the lower third molar may be

easily extracted with the elevator by passing the beak down on the mesio-buccal angle between the root and the alveolar wall, and prying it out.

EXTRACTING ROOTS.

Decidedly the best instrument for extracting roots is the universal spicular root forceps, Fig. 98, p. 129. The beaks, being narrow and sharp, pass easily beneath the gum and effectually seize the root, rendering the use of the gum lancet unnecessary. The forceps should be pressed upward with a rotating motion till the connection between the root and the jaw is entirely broken.

In the case of recently-fractured teeth it may be necessary to cut through the alveolus, for which purpose this same forceps may be used for the ten anterior teeth, or the alveolar forceps, Fig. 100, p. 130, for the upper jaw, and Fig. 101, p. 131, for the lower.

Roots of upper molars, when firm in the jaw, may be best removed with the cowhorn forceps, placing the inner beak over the palatal root so as to get a firm support, and the cowhorn placed immediately over one of the buccal roots, closing the instrument the cowhorn will pierce the alveolus and impinging upon the root will easily start it from its socket. Without removing the instrument open the beaks and repeat the operation on the other buccal root. Remove the instrument from the mouth, and with the spicular forceps remove the loosened buccal roots and extract the palatal root.

In case of necessity the inner beak may be placed far up on the palatal surface of the gum, and the cowhorn used as before described. The instrument being carefully removed leaves only a simple wound of the gum, which readily heals.

Roots of lower molars may generally be successfully removed with the lower cowhorn, Fig. 95, p. 127. Place the inner horn of the instrument on the gum, well down over the

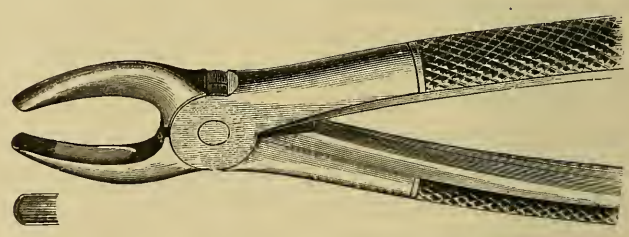
alveolus, then use the outer horn upon the root, as described for the use of the cowhorn on the upper molar roots.

The alveolar forceps may also be successfully used for removing these roots.

Special directions for extraction of the temporary teeth need not be given, as they offer no peculiar difficulties, but caution should be exercised not to injure the succeeding permanent teeth.

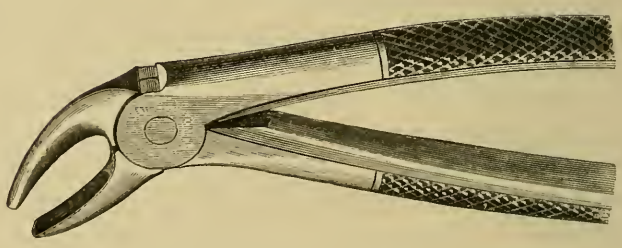
The English forceps * are much smaller than the American make. They are strong, and peculiarly well adapted to the purpose for which they are made. The following figures show some of the more important and characteristic forms—

Fig. 102.



Upper Incisors and Cuspids.

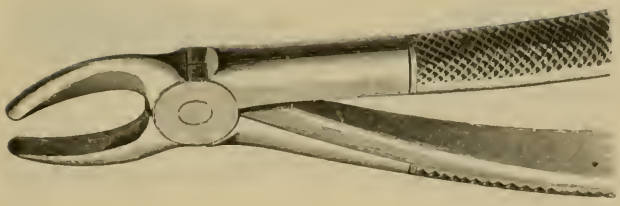
Fig. 103.



Lower Incisors and Cuspids.

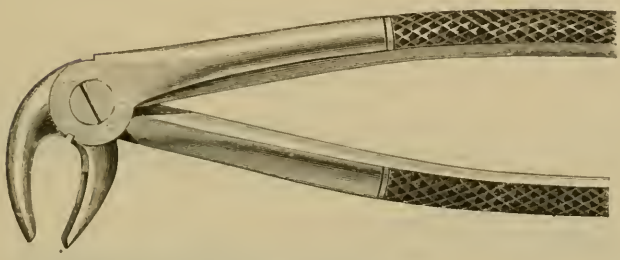
* The cuts of these were furnished by Claudius Ash & Sons, London.

FIG. 104.



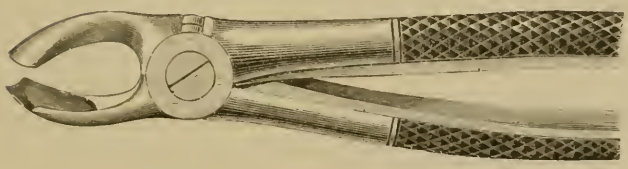
Upper Bicuspids. Either Side.

FIG. 105.



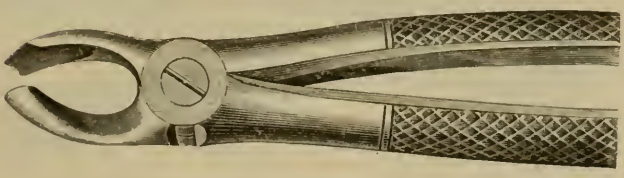
Lower Bicuspids.

FIG. 106.



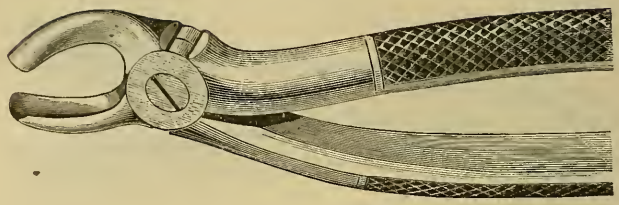
Upper Molar. Right Side.

FIG. 107.



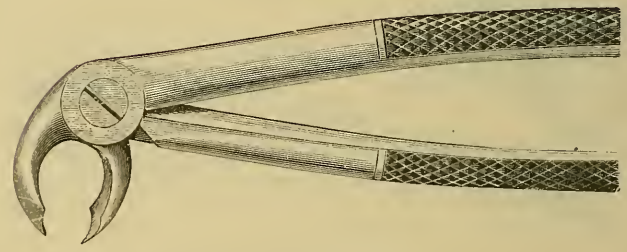
Upper Molar. Left Side.

Fig. 108.



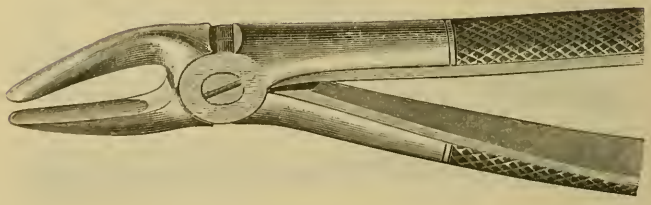
Upper Third Molar. Either Side.

Fig. 109.



Lower Molar. Either Side.

Fig. 110.



Upper Root.

Fig. 111.

Lower Root.

ELEVATOR.

An elevator is sometimes very useful for the removal of roots of teeth, but since so great improvement has been made in the construction of forceps it is not so much used as formerly. The Cooledge elevator with two blades, formed like Fig. 112, is of universal application, and will serve all purposes for which an elevator may be required. The elevator is used by passing the blade down by the side of the tooth, using the edge of the alveolar process as a fulcrum for prying it out. Sometimes the adjacent tooth may be used as the fulcrum.

The Key.—Since the perfection of the forceps, the key has fallen into disuse, and it is severely criticised and condemned by most of the profession. A few operators have continued to use it, and find in it such merit that a description of its use is with propriety included in this chapter, and each teacher and practitioner will judge it on its merits.

This instrument, used with skill, extracts many teeth with great ease for the operator and little pain for the patient. It is especially adapted for the removal of the eight bicuspid teeth and roots. The fulcrum should be round, about three-fourths of an inch in length from centre of shaft and one-half inch in thickness. The hook must be long enough to reach well down on the outside of the jaw, and well curved so as not

to be thrown off by contact with the crown of the tooth when force is applied to extract it. The hook should have but one

Fig. 112.

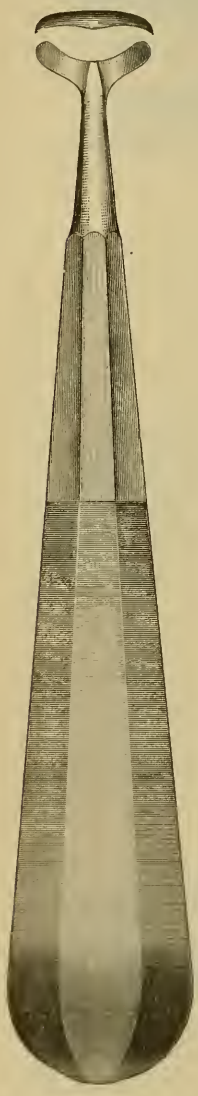


Fig. 113.

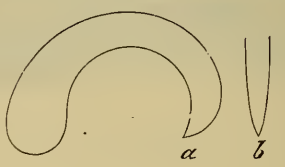


Fig. 114.

point, sharp and well tempered, shown in Fig. 113. Pad the bulb with wet cotton, tied on, or a small napkin wound around it —a permanent pad becomes foul. Fig. 114 shows the fulcrum and hook properly constructed.

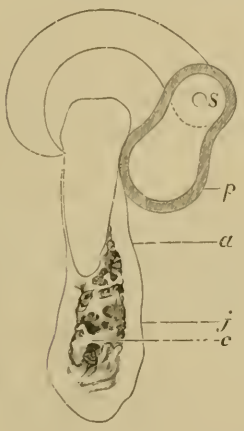
Place the fulcrum on the inside of the jaw opposite the tooth to be extracted, and rest it on the edge of the gum well up on the neck of the tooth. If placed down on the gum the force is exerted too much laterally, and fracture of the tooth is likely to result. If the tooth be strong, place the point of the hook on the neck at the buccal side of the tooth, pressing down the gum a little, but not sufficient to wound it. When adjusted, as in Fig. 115, rotate the shaft inward gently until you feel that the hook is fixed, when a quick, resolute turn of the hand will extract the tooth instantly, and in almost every case to the great surprise of the patient that it hurt so little.

The natural inclination inward of the bicuspids (see Fig. 115), the taper of the

root toward the apex, the extreme thinness of the outer wall of bone, and the substantial thickness of the inner plate, render the direction of the force exerted by the key extremely favorable.

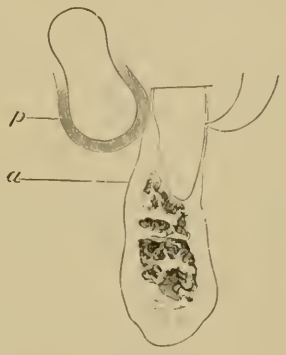
If the crown be gone below the margin of the gum, the fulcrum must be placed a little further down on the jaw, and the hook placed well down on the gum, even one-third of an inch from the margin, as in Fig. 116. Then apply force as before, and the hook will penetrate the gum and alveolar wall, catch the root and remove it with great facility, making a clean cut

Fig. 115.



S, SHAFT OF KEY. P,—PAD.
A, ALVEOLAR WALL. J, JAW.

Fig. 116.



P, PAD.
A, ALVEOLAR WALL.

through to the edge without lacerating the gum or fracturing the bone. If properly used, the fulcrum will not bruise the gum at all.

Some operators strenuously advocate its use for extraction of the molars, especially of the lower jaw. In these cases the fulcrum may be placed either on the lingual or buccal side of the tooth, preferably the latter, as the force thus applied acts more in accordance with the anatomical construction of the parts.

As forceps are numbered by the hundreds, it is impossible and undesirable to describe them all in this work. When the operator shall have learned well to use those already mentioned, he will then be able to select such additional instruments as shall suit his individual taste.

ANÆSTHESIA.

Anæsthesia is a state of insensibility, induced by any means or conditions whatever. As used in dental practice, it means a state of insensibility induced at the will of the operator by the administration of medicinal agents, usually by inhalation.

Ether, nitrous oxide gas and chloroform are the only agents in general use for this purpose. Their effect is produced by their action upon the brain, the parts of which are affected in the following order:—

First. The *cerebrum*, benumbing sensation and volition.

Second. The *cerebellum*, affecting the coördinating power.

Third. The *medulla oblongata*, depressing the powers of organic life, viz., circulation and respiration.

Anæsthesia may be divided into three stages, although no marked line of division appears:—

First. *Stimulation.* The patient is more quiet, the pulse is stronger and beats more regularly.

Second. *Excitement.* Consciousness begins to be lost, the pulse is quickened, the face flushes, the patient is easily frightened, sounds are exaggerated, muscular movements are irregular and often violent, owing to loss of coördinating power, and soon become spasmodic. The amount and duration of the excitement depend largely upon the mental condition of the subject when commencing to inhale, and upon the degree of mental control exercised by the operator, and the quiet and order around.

Third. *Profound insensibility.* The muscular system becomes relaxed, the skin is insensible, the eyelids do not

respond if the lashes be touched, the conjunctiva is insensible to touch of the finger, the pupil is dilated. Still more profound insensibility is indicated by relaxation of the sphincter muscles, the sphincter ani being the last to succumb, by stertorous breathing, slowing and weakening of the pulse, shallow breathing and profuse sweating.

In typical anæsthesia as produced by ether, especially when rapidly inhaled, sensibility to minor operations is entirely lost before other powers are sensibly affected, and at this point a single tooth may be extracted, or a single incision made, without any pain being felt, although the patient may be quite conscious of all that is being done. This condition is indicated by insensibility to pinching of the skin, and by the dropping of the hand, which was voluntarily held up by the patient at the beginning of the inhalation. Next consciousness is overcome, and by this time the coördinating power is considerably diminished and very soon lost, and loss of all muscular power quickly follows.

This stage may be maintained for a long time without the circulation or respiration being sensibly lessened, and severe and prolonged operations performed. If anæsthesia be pressed further, the pulse, which at first is full, strong and quick, becomes weak and less frequent, and the respiration more shallow, showing that the medulla is affected.

Anæsthesia that is produced quickly passes off quickly. It is quite practicable to induce anæsthesia, perform an operation and have the patient recover, without apparently affecting the medulla at all, consequently no nausea follows.

It is prolonged anæsthesia that produces nausea. The medulla seems to be affected in proportion to the length of time that the agent is inhaled.

Nitrous Oxide.—Relaxation of the muscles is not constant nor common in anæsthesia produced by nitrous oxide gas. Contraction instead of relaxation is likely to follow, and a spasmodic twitching of the muscles takes place, an interrupted, jerky inspiration, and a turning inward of the thumbs toward

the palm of the hand. Beyond these indications it is not safe to affect the patient.

Nitrous oxide gas is the agent par excellence for the dentist's use. It is a stimulant to the heart, and is as safe as anything producing such results can be. Deaths reported do not exceed one in one hundred thousand administrations, and in all fatal cases reported the cause of death has been somewhat in doubt.

If the gas is pure, unpleasant results seldom follow its use. It is nearly odorless, so is not unpleasant to have about the office; it is non-irritating, hence not disagreeable for the patient to breathe; it acts quickly, produces a profound narcosis and passes off very rapidly, leaving the patient with a clear head and full pulse, ready to go on his way by the time the blood is sufficiently staunched to permit it.

If impure, as gas manufactured in a dental office is likely to be, unpleasant effects, such as nausea, dizziness, lassitude and headache, may follow and persist for several days or weeks.

When administering the gas the supply should be abundant and free. All air must be excluded, as a very small per cent. mixed with the gas will prevent its narcotic effects.

An inhaler with a rubber face-piece covering the mouth and nose, and a double-acting valve is much to be preferred.

Apply the inhaler to the face, having put a prop between the teeth, and allow air to be breathed until respiration is regular, then with the consent of the patient change the valve and admit the gas. The substitution will hardly be noticed, and in from one to two minutes, rarely three, anæsthesia will be produced, lasting long enough to extract from one to twenty teeth, according to the susceptibility of the patient, the dexterity of the operator, and the difficulties of the operation. The narcosis will last as long as that of any other agent which will produce it as quickly.

Inhalation of gas may be repeated, anæsthesia having been induced as many as four times at one sitting.

The gas may be allowed to escape from the cylinder into a

bag from which it is breathed, or better, into a gasometer holding from twenty to thirty gallons, and breathed through a tube from this. This insures an abundant supply and prevents waste of gas.

Any inhaler which compels the reinhalation of expired gas should be condemned.

The mode of death from inhalation of gas is from failure of respiration, the irritability of the heart persisting for some time after respiration has ceased.

Ether.—Ether is a safe and effective anæsthetic, and is especially suited to prolonged operations on account of its cheapness, manageableness, and its power to relax the muscular system. It also stimulates the heart.

Its odor is very disagreeable, penetrating and persistent. It passes out of the system slowly. In full strength it is at first irritating to the air passages and produces coughing.

The ordinary way of giving ether is by holding a towel folded several thicknesses over the face and pouring ether upon it, or a large cone sponge over the face without covering. These means are effectual, but wasteful of ether, allowing much to escape and fill the apartments with the vapor.

A more economical and perhaps neater way is to use a wire framework lined with lint, or a cone sponge, and over it a towel pinned closely; over this may be folded a paper covering, as there will be no trouble about letting the patient have air enough. Have the size and form to fit the face without the sponge or lint coming in contact with it. Have the sponge or lint wet with water, as ether does not evaporate well from a dry surface.

When everything is in readiness, pour on to the inhaler at first sufficient ether to produce the anæsthesia (one or two ozs.), as removing it to add more prolongs the operation very much. Let the patient inhale a very dilute vapor at first until the membrane of the air cells and tubes becomes somewhat affected and a state of tolerance induced; gradually approach the inhaler, withdrawing a little if the patient chokes or

coughs, until the full strength can be borne, which will usually be after about half a dozen inhalations; then crowd the inhaler close, so as to shut out nearly all air, and narcosis will be very quickly induced—in from two to four minutes. If the patient suffers for want of air, more must be admitted; but admit no more than is necessary, for, by exclusion of air, narcosis is much more quickly produced. Remove the inhaler and perform the operation. If the patient is anæsthetized in this way and then allowed to come to at once, nausea will seldom be experienced. Ether narcosis should not be repeated at the same sitting, as it is almost sure to produce sickness.

Conditions Unfavorable to Anæsthesia.—*Alcoholism* is a condition unfavorable to the production of anæsthesia. It is generally difficult and often impossible to produce it, and it is attended with unpleasant symptoms. There is no danger in attempting it, but if unfavorable symptoms appear the attempt should be abandoned.

Advanced heart disease is an unfavorable condition, as enlarged heart with atrophied walls, valvular disease or fatty degeneration; but in these cases the narcosis is no more dangerous than the shock of the operation. If a patient is able to come to an office without distress or inconvenience on account of heart trouble, the operator may feel well assured that any disease of the heart is not far enough advanced to render the narcosis at all perilous on that account. Diseased lungs or general debility, if not too pronounced, do not forbid.

If physical depression follows the use of an anæsthetic, it is much more likely to be the effect of shock than of the narcosis.

In ether narcosis death follows from failure of respiration.

Chloroform.—Chloroform has a direct depressing influence on the heart's action. It is also a very powerful agent, and consequently is very dangerous to use. So many fatal results have followed its use in dental practice, that to continue it seems to be wholly inexcusable.

If this agent be given, the atmosphere to be breathed should not contain more than two to four per cent. of chloroform

vapor; six per cent. is not safe, eight per cent. is decidedly dangerous, and twelve per cent. is likely to prove fatal. Its odor is agreeable, hence it is pleasant to take, and the temptation to use it is great. Death occurs from failure of the heart, and it is likely to occur in the early stages, often before consciousness is lost. A single inspiration of strong vapor may produce the fatal result. An inhaler should be used which absolutely controls the strength of the atmosphere. The ready method of napkin or handkerchief should never be adopted.

Chloroform narcosis is usually easy, pleasant and prolonged, and its after-effects not disagreeable.

Rapid Breathing as a Pain Obtunder.—Place the patient in a reclining position upon the side. Place a handkerchief over the face to produce quiet; have the patient breathe *rapidly* —about one hundred times a minute, rapidly expiring. In two to five minutes partial or entire insensibility is obtained. This is more applicable to women than men, and is not applicable to children.

Local Anæsthesia.—Of the various means to produce local anæsthesia, the spray of ether or rhigolene applied by the atomizer is the most convenient and effective. The teeth and contiguous parts must be made dry and kept so, and the spray directed upon them gradually, that the patient may bear it without shock from the sudden cold. In from thirty to sixty seconds the full effect will be obtained, when the teeth may be extracted.

Too great or long continued cold must be avoided, as sloughing may result. This method is now little used, the cold being so painful.

Ether or chloroform applied on cotton to the gum around the tooth for one or two minutes will lessen the sensibility in a marked degree.

Unfavorable Symptoms.—When giving gas, the face of the patient sometimes becomes quite livid. This is due in part to asphyxia and in part to nervous conditions, bringing the venous blood to the surface, but more largely to impurities

in the gas. The symptom has become much less frequent since the introduction of liquid gas. This is not to be considered an alarming symptom, and absolute purity of the gas will prevent it.

Nausea occasionally follows, but is only the result of profound anæsthesia, and soon passes away, requiring no treatment.

In a few instances suspension of respiration has occurred, for which a sudden shaking or a slap upon the back has proved a sufficient remedy. The mode of death from gas is by failure of the respiration, and if suspension of the respiration continues, the patient should be laid upon the floor and artificial respiration be resorted to as long as irritability of the heart exists, which may be for an hour or more.

The unfavorable symptoms of ether narcosis are, occasionally an extreme paleness. The remedy for this is the temporary suspension of the inhalation, and the administration of some alcoholic stimulant. Muscular contractions with irregular positions and motions of the eyes, indicating an undue disturbance of the nervous system, is an annoying, if not a dangerous symptom, and demands prudence and moderation in the administration of the anæsthetic, if not an entire suspension.

Nausea and vomiting are sometimes persistent and distressing. Bromide of potassium in doses of fifteen to thirty grains, repeated if necessary, is a good remedy.

The mode of death from ether being by failure of respiration, if danger appears from this cause, resort at once to artificial respiration.

The unfavorable symptoms attending the administration of chloroform are due to its action on the heart. Its less serious effects are indicated by an ashy paleness of the patient, its more serious and dangerous effects by a weakening of the pulse, or sudden and entire failure of the circulation. The remedy for the first symptom is a suspension of the inhalation and a free supply of air. For the second, promptly lower the head and shoulders, elevate the limbs and employ artificial respiration. The prospects for resuscitation in such cases are not favorable.

CROWN WORK.

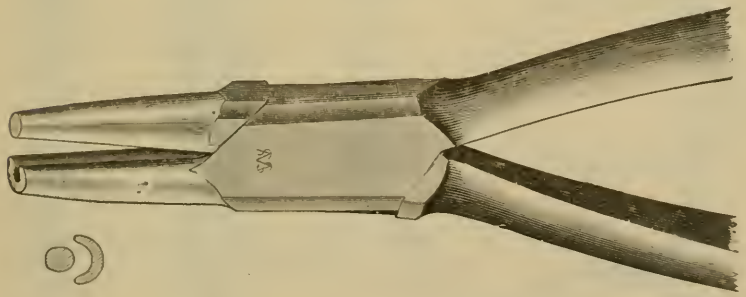
The methods of attaching porcelain crowns to natural roots are very numerous and varied.

The following directions will serve for mounting a number of kinds of serviceable crowns. For an exhaustive discussion of the subject, the student is referred to the files of the *Cosmos* and other dental journals and to the "American System of Dentistry," Vol. II.

It is presumed that the operator understands metallurgy, including the working of metals, and that he has a reasonable conception of the principles of mechanics and the ability to apply them. A student is not expected to comprehend all the details of Crown and Bridge work without an instructor, for it is not possible to illustrate and describe every point so as to be fully understood by a novice.

The following list contains the most of the instruments needed for this work:—

Fig. 117.



A clasp bender, Fig. 117.
Contouring pliers, Fig. 118.
Long pliers for soldering, Fig. 119.
Small pliers for handling solder, Fig. 120.

Fig. 118.

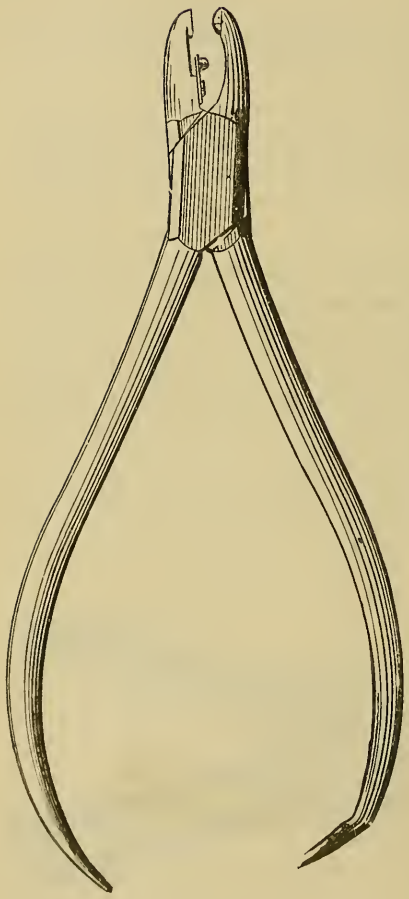


Fig. 119.

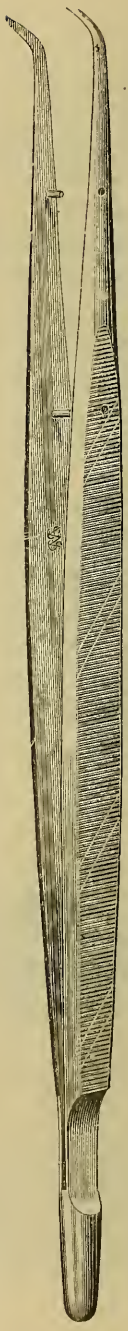
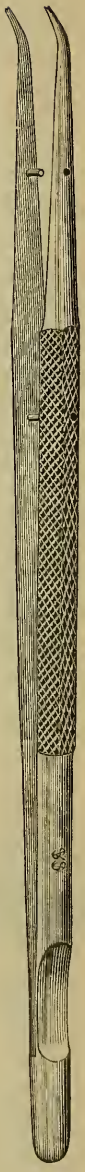
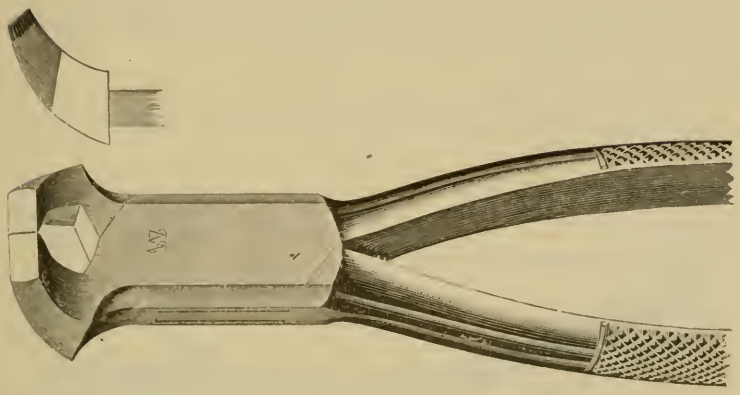


Fig. 120.



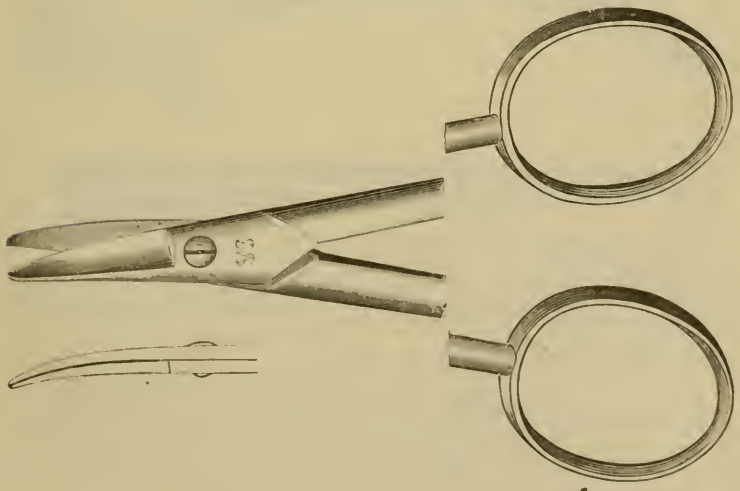
Jack's hard bits, Nos. 13 and 14. (Fig. 12, p. 32.)
Bennett's chisel excavators, Nos. 5 and 6.
A hoe-shaped cutter.
Excising forceps, Fig. 121.

Fig. 121.



Scissors. Fig. 122 is a pair of surgical scissors for cutting plate.

Fig. 122.



Hand and engine drills, Nos. 14 and 15, standard wire gauge, for pulp canals.

Corundum disks, stones and points for engine.

Soldering clamps.

Engine burs—round and barrel, Nos. 10 and 12, and wheel, Nos. 18 and 20.

Bunsen burners, one with stand for drying and heating cases and for soldering.

One mouth blow-pipe.

A Knapp nitrous oxide compound blow-pipe is an excellent addition.

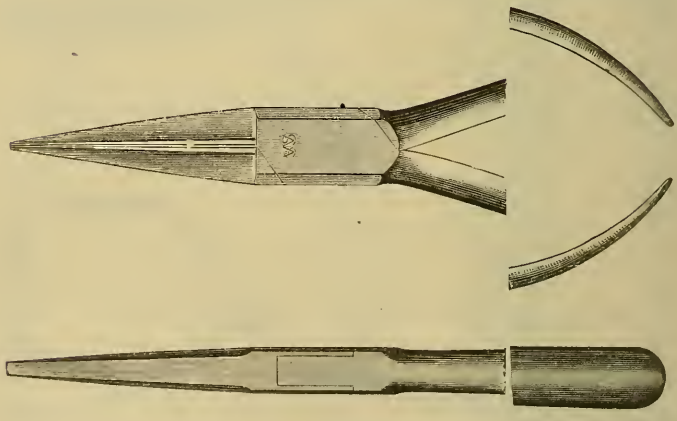
Copper plate, No. 32.

Pattern tin.

Excavators—hatchets and hoes.

Pliers, Fig. 123.

FIG. 123.



Cutters, Fig. 124, for trimming plate.

Investment material, equal parts plaster and marble dust or sand or asbestos.

Die metal, melts at 176° F.

Bismuth,	20	parts.
Lead,	12	"
Tin,	7	"
Mercury,	4	"

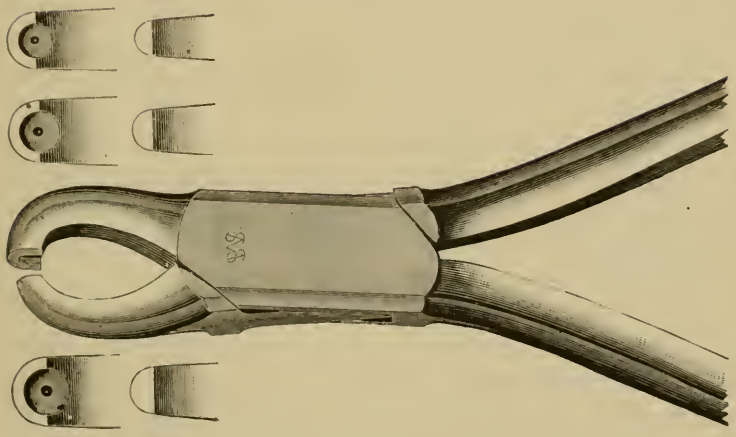
Or die metal, melts at 151° F.

Bismuth, 7½ parts.
Lead, 4 "
Tin, 1½ "
Cadmium, 2 "

Or die metal, melts at 212° F.

Bismuth, 2 parts.
Lead, 1 "
Tin, 1 "

FIG. 124.



Oxyphosphate cement, slow-setting.
Gutta-percha, soft-working.
Finishing and polishing instruments and materials.
Straight-grained wood; birch is best.
Cement wax—beeswax and resin, equal parts.
Iron binding wire, No. 27.
Pure gold plate, No. 31.
Twenty-two-carat gold plate, { Gold, 22, / Silver, 2, } No. 30, or gold coin, No. 31.

No. 1, 18-carat solder, { Gold, 18 parts. / Silver, 4 " / Copper, 2 " } No. 27.

No. 2, 18-carat solder, { Five dol. gold coin, 129 grs. / Spelter solder, 12 " / Silver coin, 12 " } No. 27.

Platinum iridium wire, Nos. 14 and 15, barbed, or a screw thread cut upon it.

Platinum plate, No. 32, may be substituted for the pure gold in some places.

Preparing the Roots.—The preparation of the root is nearly the same for each method.

Make the root healthy and plug the apical foramen. (See page 100.)

Cut off with round or barrel burs and corundum disks, the remaining portions of the crown even with the margin of the gum, or a little below it, so the joint will be covered, especially on the labial surfaces of the upper front teeth. If a large portion of a crown is to be removed, cut a groove, with small burs or disk, around the neck of the tooth, well into the dentine, and then cut it off with the excising forceps, Fig. 124, and bur off the root as above described.

If a band is to be fitted, dress down the sides of the root parallel so that a band passing over the end will fit accurately throughout its whole extent. The hoe-shaped cutter serves the purpose well. Pass the instrument under the gum and draw it toward the surface, scraping off the projecting portions until the portion of the root to be embraced by the band is reduced to a uniform size.

Drill out the root canal three-fourths the length of the root, with a drill corresponding in size to the post-wire to be used. The opening of the canal may sometimes be widened to admit a post flattened at the cervical portion, as in a Logan or Parmly Brown crown.

When enlarging and forming the pulp canal, care must be

exercised to follow the direction of the canal and not perforate the wall of the root. For a guide, use a flexible probe to determine the direction and depth.

The canal must not be drilled beyond any considerable curve of the root. The engine should seldom be used. Hand instruments are much safer and more accurate.

Richmond Crown.—The crown now known as the Richmond or cap crown consists of a metal dowel pin, a gold cap and a porcelain front, the latter being attached by a gold backing soldered to the cap and pin. (Fig. 125.)

To mount one of these crowns, after cutting the tooth off

FIG. 125.

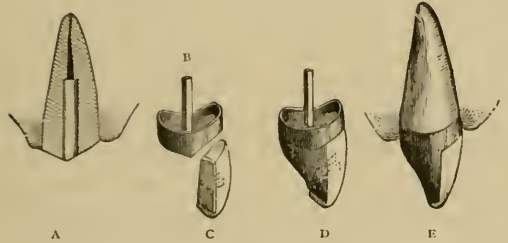


FIG. 126.

and before grinding it to exact length, dress it down to a uniform size. (Fig. 126.)

Pass a piece of fine iron or silver binding wire around the root, tighten it by twisting the ends together, and form it to the root, as in Fig. 143. Remove the wire without changing its form, lay it upon an anvil, and place upon this the end of a piece of fine, straight-grained wood, and with a hammer strike the wood, thus embedding the wire in it. Remove the wire, and an impression the exact form and size of the root will be left in the wood. Cut down the wood to this, just removing the impression made by the wire. This will be the size and form of the root. With the clasp-bender fit around this a band of twenty-two-carat gold, No. 31, sufficiently wide, usually about one-fourth of an inch, to allow trimming to fit the festoon

of the gum. The ends of the band may lap, the inner end being filed down to a thin edge. Confine this with binding wire, and try it upon the root to insure its exact adjustment. Remove and unite with No. 1 solder, then replace upon the root and mark the line of the festoon of the gum; remove and file or grind down to the line. When properly fitted, the band should pass under the gum throughout its circumference, but not far enough to impinge upon the pericementum.

Dr. Baker fits a band "by using copper rolled down quite thin and three-fourths of an inch wide, wrapped about the root of the tooth and forced up under the gum. A ligature is passed around both; the copper band is burnished down and the ligature drawn tight. The copper band will now fit just about as we want the gold band to do. Plaster is then inserted in this, and forced up against the end of the root and permitted to set. Take it off and lengthen the root end by a piece of paper wrapped about it. Then the melted die metal may be poured into it, and thus a perfect model of the end of the root be secured. The model will, perhaps, need a little dressing down with a file, when the gold band may be fitted around it, and thus avoid annoying and painful trying-on in the mouth."

Some operators prefer to fit the band directly upon the root. This may be readily done, but it is more painful to the patient. To do this, fit the band as nearly as possible with the clasp-benders, then bind it with wire and place it upon the root, and complete the fit with a burnisher and by tightening the wire, remove and solder. Remove the band and grind off the root to the exact length required, grinding the labial side a little under the gum. (Fig. 125, A.) Replace the band and mark on the inside the outline of the surface of the root. Cut away the band to this line, when it will be found to correspond to the end of the root. Take a piece of pure gold, well annealed, No. 31, large enough to cover the end of the root. Fit and solder this to the band, holding it in place with pliers or with a clamp, making a cap to cover the end of the root. (Fig. 125 B.)

Place the cap on the root, and with a sharp drill cut a hole in the cap over the root canal large enough to admit the dowel-pin of platinum-iridium, either round or flattened. The dowel-pin should be barbed or roughened. Cut it off somewhat longer than will finally be needed. Remove the cap and pin and fasten with strong cement wax; replace to secure correct relation of pin and cap; remove carefully and invest, and when fully set wash off the wax, cut off the superfluous length of pin, and solder. Grind off any surplus solder or pin and place the cap on the root. Select a plate tooth with cross pins of proper shade, size and form, and grind it to fit in position. (Fig. 125 c.) Back the tooth with pure gold, No. 31, fastening the backing in position by bending the pins a little. Usually the backing should extend to the cutting edge, but occasionally, on account of darkening the color, it may be cut back nearly to the pins.

Attach the tooth to the cap with wax, place in the mouth and obtain the correct position of the crown. Remove, invest, solder and finish, and the crown is ready for insertion. (Fig. 125, D.)

Make the crown and root perfectly dry, mix good, slow-setting oxyphosphate of zinc cement, rather thin, the consistency of common cream; place some in the root canal. A coarse broach serves well to work it into the canal. Fill the cap and immediately carry the crown firmly to place; hold until the cement is set, when the surplus, which has been pressed out around the root, may be removed.

The six anterior teeth are made as above described.

To form a bicuspid, proceed as for an incisor or cuspid until the porcelain front is fitted and backed, then fasten the crown to the cap with strong, hard wax, adding enough of the wax to equal the size of the crown, and to receive the impression of the occluding teeth. After the occlusion has been obtained, remove from the mouth and harden the wax by cooling, then scrape a little from the grinding surface to shorten the bite as much as will equal the thickness of the gold plate. A piece

of pure gold well annealed, No. 31, of proper size, may be conformed to the grinding surface of this wax model by rubbing down with a ball burnisher, taking care that the outer edge is in close contact with the gold backing of the porcelain front. Invest for soldering, wash out the wax and fill this space with pieces of gold plate set edgewise, of proper size, to complete the contour, then flow No. 2 solder to make the crown solid.

Finish and insert as in other cases.

Gold Cap Crowns.—For molars, the gold cap crown is generally used, the porcelain front being unnecessary in the back part of the mouth.

Dress down the remaining portions of the crown with corundum disks, or by other means, to a uniform size corresponding to the neck, preserving such parts of the crown as are strong, and reducing the grinding surface sufficiently to allow for the thickness of the cap.

Fit and solder a band as for a front tooth, but wide enough for the length of the crown, and trim the edge to fit the occlusion. Contour the band by bending it in with contouring pliers, cutting it up from the edge a little if necessary; then fill the band with wax and get the full impression of the grinding surfaces of the occluding teeth. Cool the wax, trim the edges to the band, and form to its surface a piece of pure gold plate in the same manner as for the grinding surface of a bicuspid. Mark its position on the band, remove the wax, replace the cap and hold it in position at some point, and attach with No. 1 solder. Perfect the position of the cap and insure contact with the band at all points, hold the pieces in position with pliers or wrap with binding wire, and solder. Place a considerable quantity of No. 1 solder inside and flow it over the cap, to strengthen the grinding surface. Finish and set with cement.

Caps for the grinding surface may also be made by striking up with dies made from typical teeth.

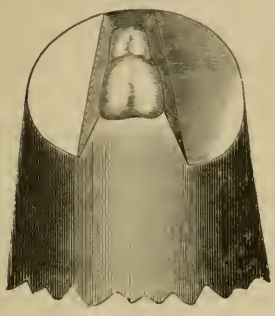
A very good contour may be obtained by making the band

a little funnel-shaped, larger at the top, and then bending in the edge to the typical form of the tooth, cutting the band in places if need be, so that it may slip by.

Then place on this the crown plate, solder and finish.

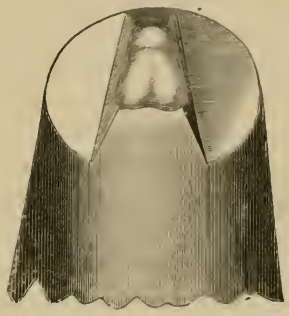
"Very artistic results can be obtained by striking up the two

Fig. 127.



A

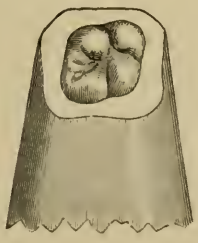
Fig. 128.



B

halves of the ferrule and a crown-plate upon dies made from natural teeth, corresponding as nearly as may be in size and shape to the typical form of the tooth to be capped. Figs 127, 128 and 129 represent a series of such dies made from the

Fig. 129.



C

Fig. 130.

D

model molar tooth seen in Fig. 130. It will be observed that around the neck of the molar a groove has been cut down to a line perpendicular to the long axis of the tooth, as previously directed in the instructions for preparing roots for ferrules.

In order that the edge of the groove may not be too sharply defined, the walls of the tooth should be beveled down to the groove edge, and at the same time ground away over their entire surface, removing in the process a layer of enamel equal in thickness to No. 27 standard gauge, or about that of the gold plate to be used in making the crown. This will make the gold crown more nearly the exact size of the model tooth; otherwise it will be larger by the thickness of its own walls, and the natural contour will thus be too much exaggerated.

"The model seen in Fig. 127 represents the contour of the buccal wall; Fig. 128 that of the palatine wall, the cervical groove made in the model tooth being reproduced in each. Fig. 129 represents the grinding surface with sharply-defined cusps.

It will be observed that exact contour of the palatine and buccal surfaces has been prolonged laterally only to the most prominent point in the proximal curvature, the model beyond this point being built out at such an angle as will prevent an under cut, and consequent breakage of the sand in moulding the die.

"The dies can be made of either zinc or brass (preferably the latter), and for each there should be prepared counter-dies of lead. By the aid of these an almost perfect representation in gold of the shape of a natural tooth, and at the same time a perfect adaptation to the root, can be secured.

As teeth of the same class vary greatly in size and shape, the making of a series of such dies for each class is, of course, necessary, if the operator desires to be prepared for cases as they present themselves. The series need not, however, be very extensive: six sets for the upper molars, as many for the lower and a corresponding number for the upper and lower bicuspids respectively, will be found ample, as the several pieces of the skeleton crown are easily susceptible of almost any modification in their general contour necessary to adapt them to a tooth of their own type.

"The dies are readily secured by taking in plaster an impres-

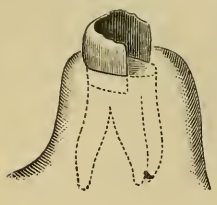
sion of the buccal and palatine half of the tooth selected as a model, this tooth being grooved at the neck and diminished in size, as before directed. The impressions being secured, are varnished and oiled, and plaster run into them after the usual manner of making casts, it being desirable, for convenience in subsequent manipulations, to make the pedestals of the casts about three inches long and two inches broad at the base, and tapering upward, so that they may readily be withdrawn from the sand in the moulding process, by which, after the ordinary methods, they are reproduced in the metallic form as dies for swaging.

"Swaging the several pieces of the crown is a very simple process. In order to determine the dimensions of the strip of gold to be used in their construction, a pattern in sheet tin is very readily secured by simply pressing it upon the die with the fingers or with burnishers. The patterns, which should be made of ample size, are reproduced in 22-carat gold, in thickness No. 27 standard gauge. By the aid of pliers, mallets and counter-dies, the palatal and buccal halves of the crown are then swaged to position upon the die and closely adapted to its surface, care being taken to press them well into the cervical grooves.

"To secure ample margin for the overlap, their free ends are somewhat prolonged beyond the mesial line of the model tooth, the shape of the dies readily permitting this. As thus swaged, the ends will diverge somewhat widely from the natural contour, but by placing them upon the model tooth (Fig. 130, p. 159), the free ends can readily be pressed and burnished into close contact with its proximal walls, the fit at all other points being perfect if the dies have been properly constructed. As the natural tooth is liable to be broken, it is well to mount it upon a conveniently-shaped plaster pedestal, sinking the roots up to the bifurcation in plaster, and reproduce the tooth and pedestal in metal. This is most readily accomplished by making with a mixture of equal parts of whiting and plaster-of-Paris a sectional mould of the tooth, drying the mould until

steam ceases to come off, and pouring in melted tin, Babbitt's metal, or other of the fusible alloys.

Fig. 131.



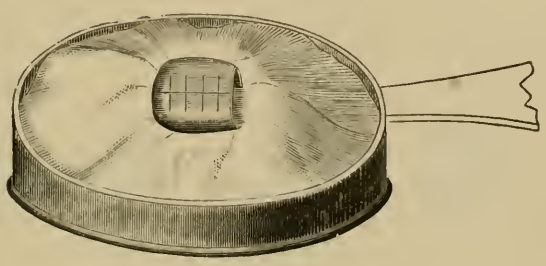
In fitting the skeleton crown to a natural root in the mouth, each half of the ferrule is separately adapted to that side of the tooth to which it belongs, as shown in Fig. 131, where the palatine half is seen pressed up under the gum. Thus placed, the adaptation of the half ring is much more readily accomplished than is that of the full ring, owing to the ease with which the sides can be compressed, and also to the greater readiness with which a full view of the interior can be obtained.

"The adjustment of the palatine half being completed, the buccal half is also shaped to the tooth, in the same manner, and to make the overlaps, both ends of each half are allowed to extend for about the twentieth of an inch beyond the mesial line of the proximate surfaces of the tooth. The limits of this overlap should be clearly marked upon both sections while they are in position around the tooth. The opposed surfaces of the two overlaps should then be very carefully beveled to each other, as already directed for the single overlap in the cuspid caps. As the sections are curved upon all sides, the beveling cannot be so readily accomplished by a file as by a small corundum wheel, which will follow all curvatures and rapidly and smoothly reduce each surface to the required extent. The bevels being made, the palatine and buccal sections of the crown are placed in position around the root, and the overlapping surfaces adjusted the one to the other, the ends of the buccal section being spread apart sufficiently to enable them to override the ends of the palatine section, after which the two halves are pressed firmly together around the root, while guide-lines are made along and across the mesial overlap. By aid of these guide-lines the overlaps are re-adjusted after the sections have been removed from position in the mouth. To hold them together, a small clamp of iron wire

may be used, but its application is often difficult, and sometimes the clamp becomes united to the gold during the soldering process. A much more satisfactory method of holding the overlapping surfaces together is to grasp them with a pair of suitably shaped spring-pliers, and then partially embed the two sections in a small mass of marble-dust slightly dampened with water and contained in a small iron cup or tray.

"After the marble-dust is well packed around the two sections, the pliers are withdrawn and sufficient borax and water applied by means of a delicate touch from a camel's-hair pencil. With a small piece of 18-carat gold plate the joint can then be readily soldered. Care must, of course, be exer-

FIG. 132.



cised in this manipulation, as any rude jar would disturb the adjustment of the parts. Fig. 132 shows the ferrule embedded in marble-dust contained in the small iron tray. The guide-lines will be observed lengthwise and crosswise of the overlap. The two sections now united into one piece are replaced upon the tooth, and the final adjustment is perfected, guide-lines being marked along the edge of the distal overlap, as shown for the mesial surface in Fig. 132. In order to secure a perfectly tight fit, press the edge of the overlapping plate a little beyond the guide-line, grasp with the pliers, anneal, to counteract the tendency to spring, as explained in connection with cuspid caps, and solder as before.

"Making the crown-plate and attaching it to the ferrule are

comparatively simple processes. Upon the die (Fig. 129, p. 159), made from the masticating surface of the model molar, (Fig. 130, p. 159), strike up a shell of gold; either pure gold (24-carat) or 22-carat gold will answer. The gold must not be thicker than No. 27 standard gauge; and if pure gold is used, it may be made very much thinner, without danger of fusion in subsequent processes. With a thin piece of pure gold (32 standard gauge), an almost perfect reproduction of cusps, sulci, and the finest markings on the crown can be obtained, the artistic effect being very admirable. The thicker the gold employed, the less sharply defined will be the outline of the shell. As, however, in actual use, sharp and prominent cusps have generally to be cut down to secure proper occlusion with their worn antagonizers, the matter is not one of much practical importance. The shell of the crown-plate should not usually extend over the body of the tooth much, if at all, beyond the base of the cusps. A good general rule is to cut the edge down almost to a level with that elevation seen on the under surface of the shell, which represents the bottom of the deepest sulcus. If such alterations have been made in the outline of the ferrule, that it does not correspond to the outline of the shell, the edges of the latter can easily be bent in or out, as the case may be, until they are of the proper shape. The edges of the shell should then be filed, down to a uniform plane, so that when laid upon a smooth and level surface it will touch at all points.

The necessity for the nicety of jointing is evident, since even a very small gap between the edge of the shell and the box-plate would afford an avenue of escape for the 18-carat filling, should it become fused in this or subsequent heatings.

For this reason great care must be taken in fitting together the ferrule and crown-plate, not to fill or cut away the protective shell or box. When, however, the ferrule and crown-plate are well united by 18-carat gold, this precaution is no longer necessary, as in all subsequent heatings the completed

crown will be subjected to a temperature only sufficient to melt the gold and zinc solder employed.

Fig. 133 shows the hollow shell. Fig. 134 the shell filled with 18-carat gold, and Fig. 135 the filled shell and box-plate clamped together preparatory to soldering. Fig. 136 is the ferrule prepared for the crown-plate. To complete the crown, all that remains is to perfect the occlusion, at the same time making a close joint between the crown-plate and ferrule, and solder them together. In making the ferrule, its free edge should have been brought almost, but not quite, up to the masticating surface of the antagonizing teeth.

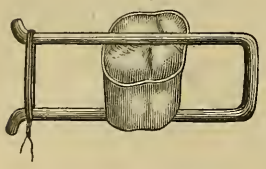
"In establishing occlusion, all that is necessary is to cut away from this free edge enough gold to allow the crown-plate to slip in between it and the occluding teeth.

Fig. 133. Fig. 134. Fig. 135. Fig. 136.

By filling the ferrule, while in position, with wax, taking the "bite" after the ordinary manner, and making a small articulating model, this detail can be accomplished out of the mouth even more conveniently than in it; by either method, however, the process is not difficult. In cutting away the edges of the ferrule, great care must be taken that it is done uniformly, so that it will fit perfectly the under surface of the crown-plate, and on such a plane as will allow the grinding surface of the crown to come in contact with the occluding tooth or teeth at the most desirable angle. The line of occlusion being established, the crown-plate and ferrule may then be joined. A clamp, such as seen in Fig. 137, will hold them together, and the projecting edge of the box-plate

serves as a convenient ledge upon which the small pieces of 18-carat gold plate used as a solder can rest. Frequently, in fitting to place between adjoining teeth, this ledge upon the proximal surfaces of the crown will necessarily have been removed, but the buccal and palatal edges need not be disturbed until the final finishing of the crown. Borax must, of course, be carefully introduced into the joint to be closed.

Fig. 137



The crown is placed upon a suitable support—preferably the bed of marble-dust, which much lessens its liability to fall off—and by the judicious application of heat the joint can be safely and securely closed. The crown is then ready for the finishing processes. The processes consist in filing off the projecting edge of the box-plate flush with the face of the crown, smoothing, contouring and beveling the free edge of the ferrule as directed for cuspid caps, and polishing with emery-powder, Scotch-stone, etc., the final polish being given by rouge carried on swiftly-revolving felt wheels.* "

THE MANDREL SYSTEM.

" In all of the various systems of crown- and bridge-work which have been brought to the attention of the dental profession, one very important point seems to have been overlooked, viz.: The comparative conformation of the necks of teeth of different classes. The general forms of the crowns of teeth have long been well known, but so far as we are informed no systematic classification of the shapes of the necks has heretofore been made. It will appear that such a classification ought to form the basis of any system of crown- and bridge-work claiming a scientific foundation.

" To lay the groundwork of the system here described, a

* Dr. Litch, " Am. Syst. Dent.," II, 840.

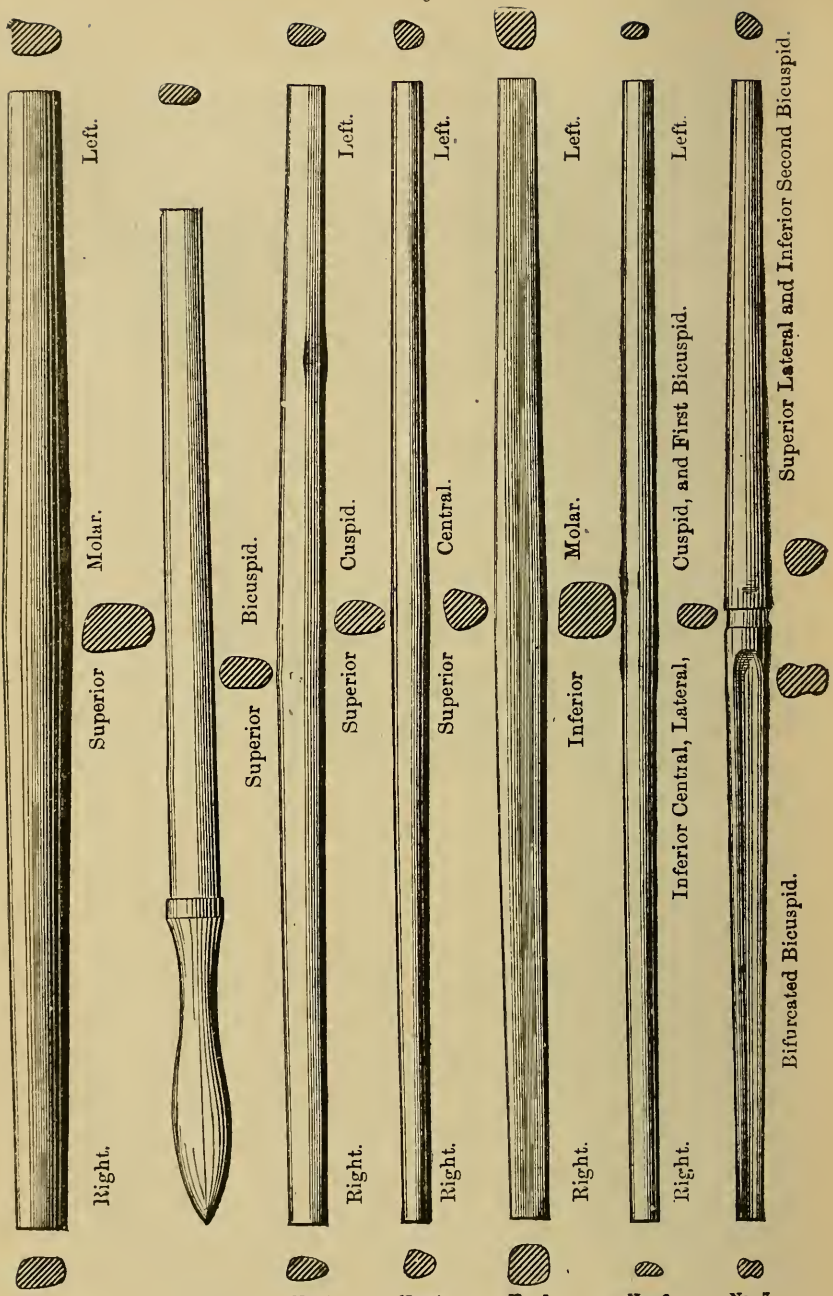
large number of human teeth of the various classes were secured, their crowns cut off, and the shapes of the stumps accurately determined, thereby developing the fact that, no matter how great differences may exist in the apparent shapes of the crowns of individual teeth of a given class, there is a remarkable conformity in the configuration of their necks. That is, the necks of the upper cuspids, for instance, were found to have a fixed type, from which the variations were very slight as to shape, though there appeared to be no exact standard of size. So of the other classes, with the single exception of the superior molars, in which two distinct forms were found, the first being those in which the buccal roots were wider than the palatal; the second, those in which the reverse condition was found, the single palatal root being wider at its junction with the crown than the two buccal roots. The occurrence of roots of the second class being rather exceptional, the first class was accepted as the type.

"The configuration of the necks of all the teeth having been determined, a set of mandrels for shaping collars to fit them was devised. The set (Fig. 138) consists of seven mandrels, six of which are double-end. Their shapes are modeled upon the general typal forms of the necks of the teeth which they represent, and they are made tapering to provide for all required variations in size. The illustrations are about two-thirds actual size, the longest instruments being nine inches in length.

"The cross-sections show the shapes and proportionate sizes at the greatest and least diameters. The long taper permits the most minutely accurate adjustment of the collars.

"No. 1 is a double-end mandrel, for superior molars, right and left; No. 2 is a single mandrel, for superior bicuspids, right and left; No. 3 is double-end, for superior cuspids, right and left; No. 4, double-end, for superior centrals, right and left; No. 5, double-end, for inferior molars, right and left; No. 6, double-end, for inferior centrals, laterals, cuspids, and first bicuspids, right and left; No. 7, double-end, one end for

FIG. 138.



Mandrels for Shaping Seamless Tooth-Root Collars.

the superior lateral incisors, the other for those bicuspids in which a bifurcation of the roots, or a tendency in that direction, extends across the neck to the crown in the form of a depression on one or both proximal surfaces. The foregoing scheme comprehends all the teeth of the permanent set except the second inferior bicuspids. The necks of these approximate those of the superior central incisors so closely in shape that it was deemed inexpedient to make a separate mandrel, as the No. 4 mandrel will serve for both.

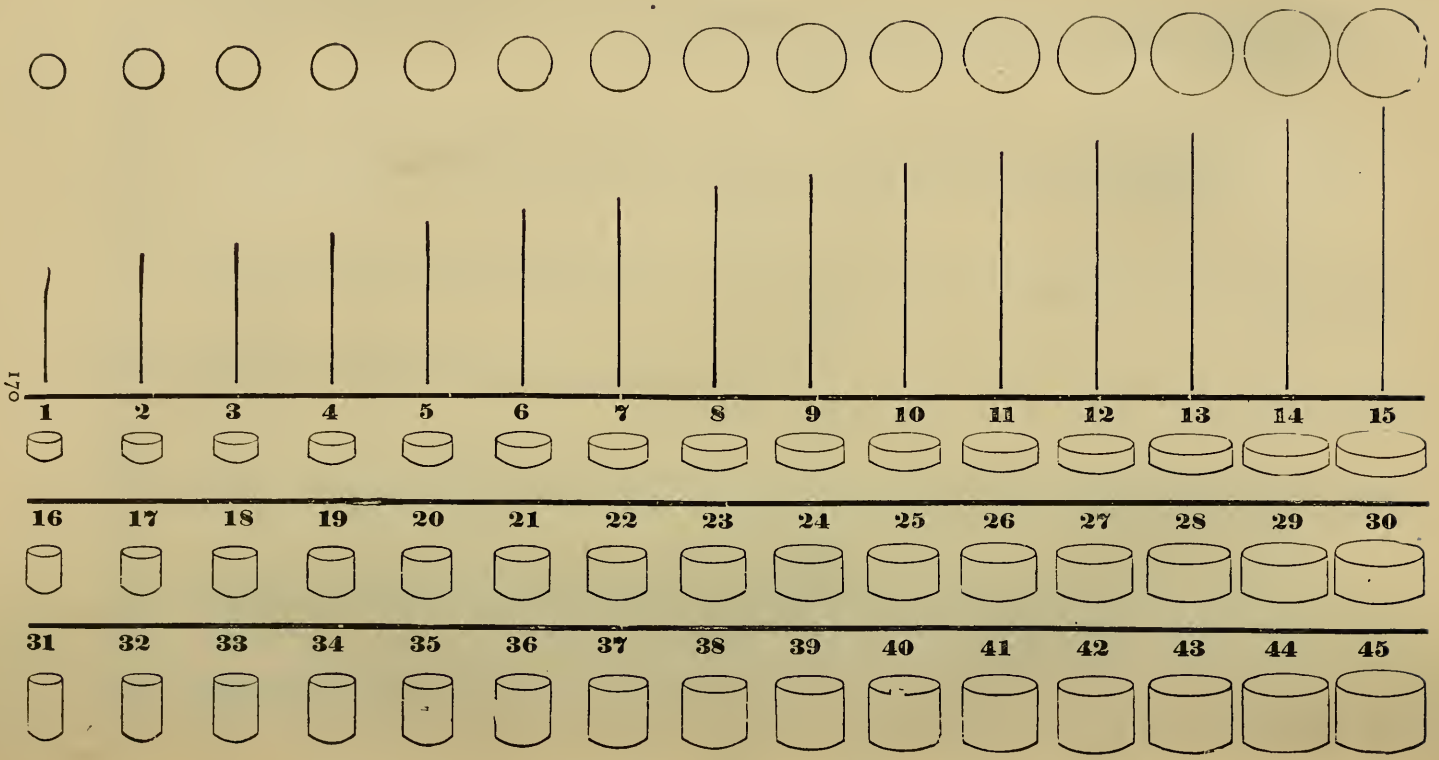
"The collars or bands are made seamless, of No. 30 (American gauge) gold plate, twenty-two carats fine. Fifteen sizes, each of three widths (one-tenth, two-tenths, and three-tenths of an inch) are made (Fig. 139), which it is believed will cover all requirements. These collars, although devised as a part of the system, can be used in all methods of crown- and bridge-work which require bands, and possess many advantages over any others. They are really labor-saving devices, as their use saves the time and trouble of making, and there is no danger of their coming unsoldered, when the pins or the backing of the crown is being soldered; and there are no hard spots to give trouble in burnishing, as, for instance, close to the root, after the collar has been shaped and placed in position, the whole surface being uniformly soft.

"The seamless collars are especially adapted to removable or detachable bridge-work. They are so constructed that Nos. 1, 16 and 31 exactly fit into or telescope with Nos. 2, 17 and 32, and so on through the entire set, each collar fits into the series next higher, so that a root may be banded with one size, and the size next larger used to form the tube for the telescoping crown. The advantages for the construction of cap crowns are obvious.

"The other appliances specially devised for this system are a reducing-plate or contractor, a pair of collar-pliers, and a hammer.

"The contractor (Fig. 140) contains holes which are complementary in shape to the mandrels. The mandrels being

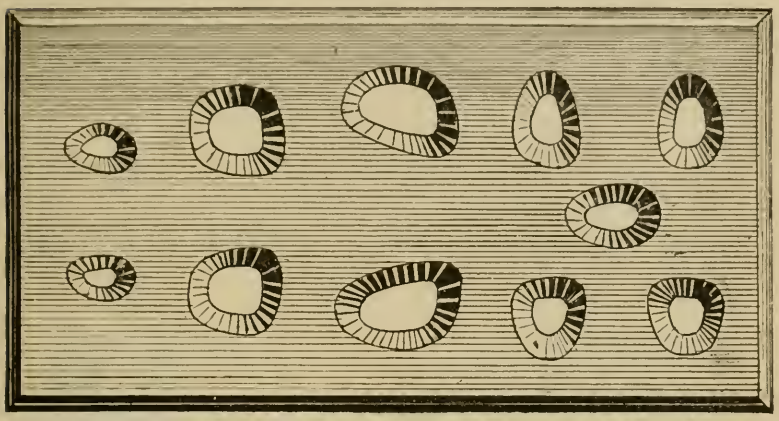
FIG. 139.



Seamless Gold Collars for Crown and Bridge Work. Copyright, 1886, by the S. S. White Dental Mfg. Co.

applied to the inner circumference of the collars, while the contractor must admit the collars themselves, the short taper of the holes in the contractor necessarily covers a greater range of size than is shown in the mandrels. With this

Fig. 140.



appliance collars can be evenly and accurately reduced in size at the edges, without burring or bucking. The illustration is actual size.

"The collar-pliers (Fig. 141) are for contouring the collars

Fig. 141.

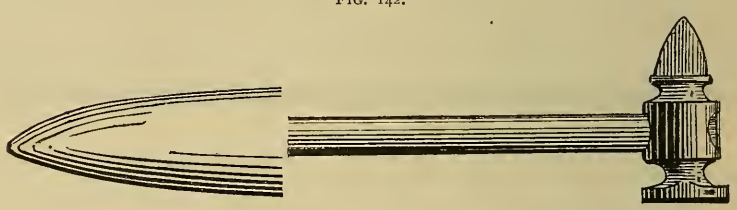
to shape, one beak being made convex, and the other concave to correspond. With this appliance the slightest changes required in the contour in the collar are easily made. About a half inch from the extremity of the concave beak a small

bar of flat steel is attached to it by means of a screw. The free end of the bar has a minute projection upon one face, the other being reinforced to fit into the concavity of the beak. In the centre of the face of the convex beak is a depression, into which the projection on the steel bar strikes, making a very efficient punch for forming guards or stops to prevent the collars from being forced too far under the gum. The depression in the convex beak being slightly larger than the projection or punch, the metal is not cut through, but merely raised on the side opposite to the punch. The punch attachment being pivoted, can be swung to one side when not in use.

"Fig. 142 is a mallet or hammer with a steel face and horn peen. The handle is nine inches long.

"One of the appliances required is a lead anvil, which being

Fig. 142.



only a piece of soft lead, say two by three inches, and an inch thick, is not illustrated. The female die of an ordinary case will answer very well.

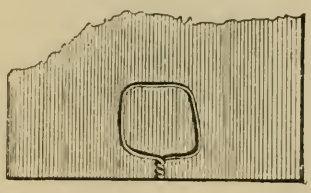
"To illustrate the uses of these appliances, take a case in which the two inferior bicuspids of the left side are missing, and the crowns of the cuspid and first molar so badly decayed that the probabilities are that they will soon fall victims to the forceps. The old-time way would have been to extract the molar and cuspids and make a partial plate. Examination, however, shows that the roots of these two teeth are in good condition, affording an excellent opportunity for the construction of a piece of bridge-work.

"With a corundum point or rotary file cut off the remain-

ing portions of the crowns level with the gum-margins. Prepare the roots in any of the well-known ways, thoroughly cleansing the apical portions, and filling them with whatever material is desired, being careful only that the work is well done. For the better retention of the filling material to be placed in the pulp-chamber, retaining grooves can be made, or retaining-posts inserted. Take a piece of binding wire (No. 26, American gauge), say two and a half inches long, pass it around the neck of the molar stump, cross the free ends, and, holding the wire in place with one finger, twist the ends with a pair of flat-nosed pliers until the wire clasps the neck closely at every point (Fig. 143). When there are any irregularities in the contour of the tooth, it is necessary to press the wire into them with a proximal burn-

Fig. 143.

Fig. 144.



isher. It is obvious that the ring thus formed will show the exact size and shape of the neck of the tooth. Remove the ring carefully, lay it on the lead anvil, put over it a piece of flat metal, and with a smart blow from a hammer drive the wire into the lead (Fig. 144). Upon removing the wire an exact impression of the ring will be left in the lead anvil. (This part of the work, as indeed all others, should be done carefully as described. The wire ring may be driven into the lead by a direct blow of the hammer face, but the blow might not strike equally, and the interposition of the flat metal held level ensures an even impression. A piece of an old file is best, as the file cuts keep the wire from slipping.)

"Next cut the wire ring at the lap, straighten out the wire,

and select a suitable collar by comparing the length of the wire with the straight lines in the diagram (Fig. 139, p. 170), which show the inside diameters of the various sizes. Should none of these correspond exactly, take preferably the next size smaller. It will be remembered that the collars are No. 30 in thickness, while the wire with which the conformation is secured is No. 26. This difference permits the collar when contoured to shape to enter the lead impression readily—a decided advantage in fitting. Having selected the collar, fit it to mandrel No. 1 with the peen of the hammer, holding it upon the lead anvil and using a slight pushing force to help in stretching

Fig. 145.

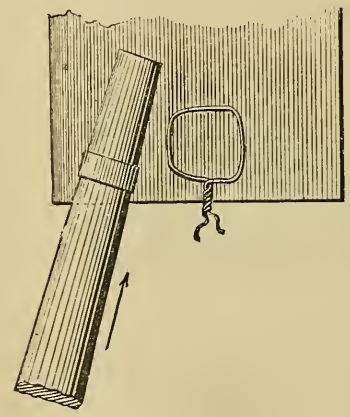


Fig. 146.

and forming it (Fig 145). Having driven the collar to form, remove it from the mandrel and try in the lead impression. If it does not fit exactly, return it to the mandrel and stretch it a little, when it will usually fit perfectly, as the mandrels have been designed carefully to the average shapes which obtain in the great majority of tooth-necks. In the exceptional cases where the collar does not fit, it can be readily contoured to the exact shape with a pair of flat-nosed pliers. Of course, if it fits the impression in the lead it will fit the neck of the

tooth, always provided the measurement and the impression have been carefully made.

"If the collar or band has been accidentally stretched too much, or if, for any reason, when brought to shape, it is too large, its root-end can easily be reduced to the proper size by the use of the contractor. Place the edge of the collar which is to fit the root in the proper hole; hold it level with a piece of file, as in taking the lead impression of the ring, and tapping lightly on the file, drive the collar into the plate (Fig. 146), until the proper reduction is made. The collar is next 'festooned' to correspond to the shape of the maxillary ridge.

Fig. 147.

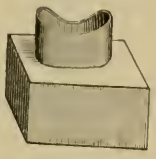
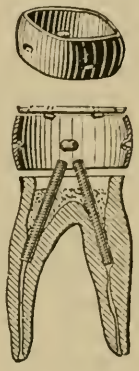


Fig. 148.



Lay it, gum edge up, on the lead anvil, and with the piece of flat file and the hammer drive it into the lead. A few cuts with a half-round file across the proximal diameter will conform the edges to the surface of the ridge (Fig. 147). Then place the collar in position, and having ascertained just how far it should go down on the root, remove it, and with the small spring punch on the collar-pliers form projections on the inside of the band at the proper points to serve as stops, which resting on the top of the root will prevent the collar from being forced further down upon it than is desirable *(Fig. 148)."

* *Cosmos*, XXVIII, 478.

This collar may support a porcelain crown or an all-gold cap, and upon these, for abutments, a bridge may be adjusted if needed.

Crown with Metal Post without Band.—The crown shown in Fig. 149 is simple, easily made, and when well adjusted, perfect in appearance.

Fig. 149.

For this crown the root should be cut off a little below the margin of the gum, and hollowed to correspond to the festoon. This may be done with an oval file, or better, with engine burs, barrel or round.

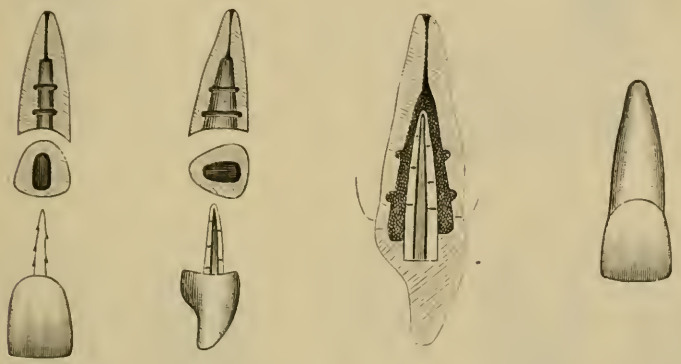
Drill the canal as before described, insert the wire for the post, and cut it off so that it projects one-eighth of an inch. Take a piece of platinum plate about the size of the end of the root, thickness No. 33, place it over the end of the root, and with the finger obtain the imprint of the wire. Punch a hole in the plate large enough to admit the wire, place it over the pin on the root, and with burnishers bend to the form of the end of the root. Remove plate and pin together and fasten with strong wax, replace on the root to insure accurate position, remove carefully, invest in mixture of equal parts plaster and sand or pumice stone. Warm the piece slightly and remove the wax, or use boiling water. When dry, solder with 20-carat solder, using only enough to unite the two pieces, then insert and burnish every portion to fit the root. The outline of the root will be marked upon the plate; remove and cut away to the exact size of the root. Reinsert, and be sure that the labial edge of the root is short enough to allow the margin of the gum to completely cover the joint, and with No. 2 modeling composition get a correct impression of this and the adjoining teeth. Place the cap in its position in the impression and make a plaster model. Grind a tooth, previously selected, of proper color and form to fit this model. Fasten the tooth to the cap with strong wax and try in the mouth to prove the position and occlusion, then invest, back the tooth with No. 28 22-carat gold plate, and solder and finish. Barb the pivot wire with a sharp knife, and the piece is ready for insertion.

Protect the root from moisture, dry the canal thoroughly, and in it place a moderate amount of easy-working gutta-percha. Hold the pin in the flame of the alcohol lamp until it and the tooth are quite hot, then carry it slowly and firmly to place. The hot pin softens the gutta-percha and the firm pressure expresses the surplus. When cool, cut away the surplus with a sharp instrument, and smooth the edges with chloroform or oil of cajeput.

Oxyphosphate of zinc also makes a good setting for these crowns.

The Logan tooth-crown is porcelain, with the post baked

Fig. 150. Fig. 151. Fig. 152. Fig. 153.

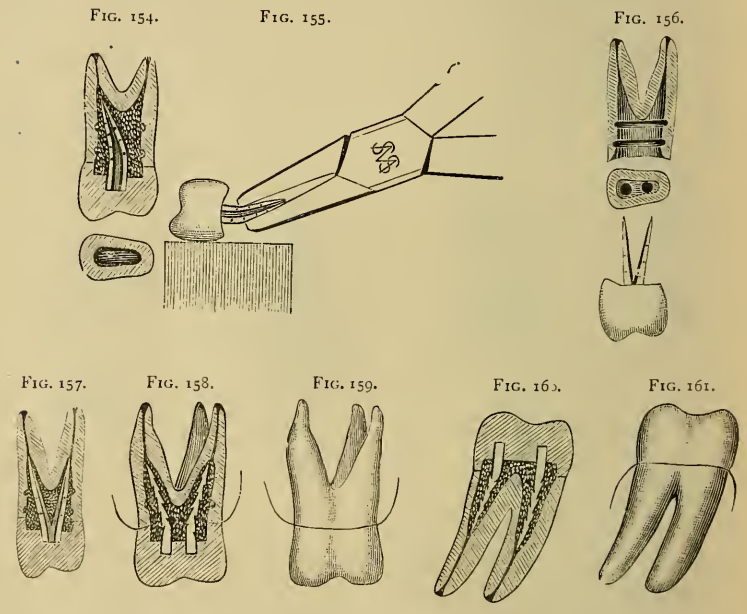


into the end of the crown. The post is widened at the cervical portion.

Dr. W. Storer How gives the following illustrated description of the best methods of mounting them;—the root is presumed to be suitably prepared.

Fig. 150 shows a superior right central root, an end appearance of the same, and a Logan crown, front view. Fig. 151 exhibits, at a right angle to the plane of the first figure, the same root, its end, and the Logan crown, side view. In both figures the pulp-canal is supposed to have been first drilled to a gauged depth with an engine twist-drill, No. 151, and then

enlarged by means of a fissure-bur, No. 70, to the tapering form shown; the walls being subsequently grooved with an oval bur, No. 90. The enlarged section, Fig. 152, shows the crown adjusted on the root by means of cement or gutta-percha, which surrounds the post and fills all the spaces in the root and crown. Fig. 153 shows the completed crown. Fig. 154 exhibits a bifurcated bicuspid root, its end appearance, and a Logan crown adjusted to the root. Fig. 155



illustrates the best manner of bending the post. Fig. 156 shows a split post, and its adaptation to a bifurcated bicuspid root is seen in Fig. 157. Figs. 158 and 159 exhibit the mode of mounting the Logan crown on a superior molar root, and Figs. 160 and 161 the same crown in its relations to an inferior molar root.

The suitable preparation of the bifurcated roots of some bicuspids and of all the molars is a matter involving difficulties

of an unusual character and requiring good judgment. The feasibility of splitting the post of a Logan crown to adapt it to the bifurcated root of a bicuspid is shown by Figs. 156 and 157. This example directs attention to the peculiar shape of the new post, in which there is effected such a distribution of its metal that its greatest strength is in the line of the greatest stress that will in use be brought to bear on the crown, while the least metal is found at the point of the least strain; the applied part of the post being in outline nearly correspondent to that of the root itself. The pulp-canal is likewise conformably enlarged to receive the largest and stiffest post which the size and shape of the root will permit.

The fitting of a Logan crown to a root is best done by the use of a wet stump wheel in the engine hand-piece, a method which affords the greatest facility for the slight touches required to abrade the thin cervical borders of the crown, which may by this means be done without encroachment on the post.

The recess in the Logan crown provides a receptacle for a considerable interior body of cement that will be deep enough to be self-sustaining internally, and yet allow the peripheral portions of the root and crown to approach each other so closely that, though only a film of packing remain, it will still be strong enough to insure the persistent tightness of the joint. This annular boss if formed of amalgam also adds strength in some cases to the mount.

When enough of the natural crown remains, it is well to leave standing some of the palatal portion, and cut the root under the gum margin at only the labial part, as shown by Fig. 164. Thus the labial joining of the root and crown will be concealed, and the other parts of the joint will be accessible for finishing and keeping clean. The Logan crown may be ground until a large part shall have been removed for adaptation to the occluding tooth or teeth without seriously impairing its strength. This crown also in such cases maintains the

translucency which is one of its peculiar excellences, owing to its solid porcelain body, and the absence of a metallic backing or an interior largely filled with cement or amalgam.

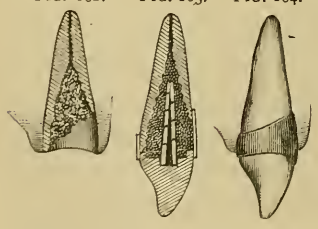
The distal buccal root of the natural superior molar is nearly always too small to receive a post of any useful diameter, and therefore the Logan superior molar crown has but two posts, which like those of the inferior molar crown are square, and thus may be easily barbed, as may also the ribbed posts of the crowns for the anterior tooth-roots. These posts are large enough in all the Logan crowns to answer in any given case, and can of course be easily reduced to suit thin or short roots.

Any of the cements or amalgams may be used in fixing these crowns, but good gutta-percha, softened at a low heat and quickly wrapped around the heated crown-post, which is at once seated in the root, forms the best mounting medium, and has the great advantage of permitting a readjustment, or if need be the ready removal of the crown by grasping it with a pair of hot pliers or forceps, and holding it until the gutta-percha is sufficiently softened.

An excellent combination for some cases is accomplished by fitting a narrow seamless gold collar over the neck of a root prepared like that of Fig. 155, and then adjusting and mounting a Logan crown in the manner described above, with the result shown by Fig. 164.

This collar combination is available in very difficult cases, as for instance when a root is decayed far beneath the gum, as seen in Fig. 162. Such an operation when completed would appear in vertical section like Fig. 163, and a view in perspective would resemble Fig. 164. The collar is also very useful whenever the root and crown are not flush and smooth at every point, as, if possible, they should always be made.

FIG. 162. FIG. 163. FIG. 164.



In all cases it is of great importance that the root should

be thoroughly dried with alcohol, or ether and hot air, in order that the cement or gutta-percha may if possible adhere to the walls of the root to exclude moisture and insure the

Fig. 165.

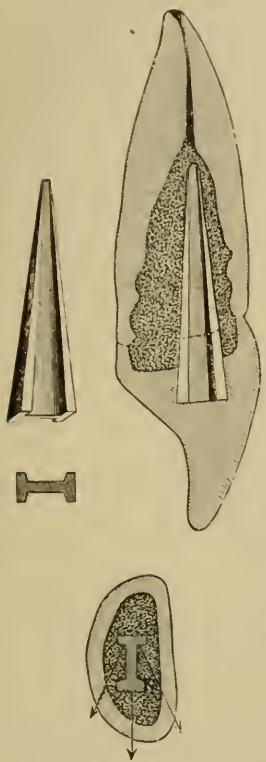
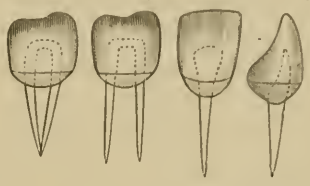


Fig. 166. Fig. 167. Fig. 168. Fig. 169.



stability of the crown; the stiff post of which will successfully resist any normal strain, as is made obvious by the enlarged views which in Fig. 165 exhibit the structure and relative capacity for resistance inherent in this form of post.*

The Parmly Brown Crown.—Fig. 169 is a lateral view of a porcelain crown with a platino-iridium pin baked in position. The pin has great strength at the neck of the tooth, where the strain is greatest, the porcelain of the tooth extending upon the pin, to increase the strength.

Fig. 168 is a front view of the same crown, showing by dotted lines the form which the metal occupies in the crown to increase the strength of the attachment and prevent the pin from approaching the surface in thin teeth.

Fig. 167 is a view of the two-pin bicuspid crown, which affords a pin for each root of a two-rooted bicuspid, the staple form of the pin shown, by dotted lines, being a feature of strength.

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* *Cosmos*, XXVIII, 500.

Fig. 166 is a view of a bicuspid crown with the two pins pressed together, making a single pin for the one root. The double pin in the bicuspid crowns prevents the loosening of these teeth by the rotary movements of mastication, which, by means of the two cusps exert such leverage as to turn and break down the ordinary crown where only one pin is used." *

The Collar Crown.—"The process to be described reduces destruction of tooth-substance to the minimum. Instead of cutting the palatine wall of the tooth down to the gum-margin, the greater portion of it is carefully conserved, its presence, while not indispensable to a successful result, being in the highest degree desirable. How much of this portion of the

Fig. 170.

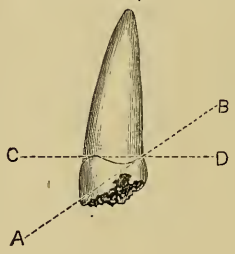
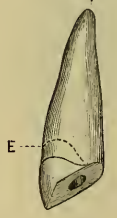


Fig. 171.



tooth can be retained will depend upon the nature of the occlusion.

"In Fig. 170 the dotted line from C to D represents the point to which the tooth is cut away in the older methods of 'pivoting;' the dotted line from A to B, the line of abscission practiced by the writer.

"As will be seen by reference to Fig. 171, the face of the tooth thus prepared presents a gradual slope from the palatal surface to the labio-cervical margin. At the latter margin the root should be cut down with suitable burs, etc., to a point a little beneath the edge of the gum, in order that the porcelain

* *Cosmos*, XXVIII, 583.

tooth in front may pass up under the gum-margin and the joint between root and tooth be concealed. At this point tooth-substance may be sacrificed, as it does not materially diminish the strength of the root.

"The several parts employed in making the collar crown are a plain-plate porcelain tooth or facing, a platinum-iridium retaining-pin, and a backing, base-plate and collar, made either of platinum, pure gold, or twenty-two carat gold, either metal being made in thickness about No. 30, American gauge. When platinum is used coin gold or twenty-carat gold, alloyed with copper or silver only, should be employed as a solder and covering. Twenty-carat gold may be used as a solder when pure gold is employed, while eighteen-carat gold will solder the twenty-two-carat plate.

"In shaping the pulp-canal for the reception of the retaining-pin, care should be taken not to weaken the root by an unnecessary enlargement of the caliber of the canal. The platinum-iridium pin need not be more than No. 14, American gauge, in thickness at its point of greatest diameter near the free surface of the root, where all the strain, if any, falls: from this point it should be made a gentle taper corresponding to the natural shape of the space it is to occupy. Half an inch in length is ample; even less will serve.

"The retaining-pin being shaped and adjusted in the root, care being taken to leave an excess in length at the free end for convenience in subsequent manipulations, the next step in the process is the making of the base-plate and its attachment to the pin. A strip of platinum or gold of suitable size is pressed upon the face of the root with broad-pointed, serrated instruments until it is in close adaptation to the surface at every point. This base-plate is allowed to *project beyond* and *overhang* the palatine portion of the root, but should not come quite to the labial edge.

"Adaptation being secured, an opening is made in the base-plate where it covers the pulp-canal, through which opening the retaining-pin may be pressed up into position in the root.

Pin and base-plate are then removed from the mouth, dried and cemented with a brittle resinous cement, and then, while the cement is still plastic and yielding from heat, placed again in position in and upon the tooth, and perfect adaptation secured. Then, while still in position in the mouth, throw upon the cement a stream of very cold water, so that it may be made brittle and incapable of bending. Then remove from the mouth and invest in a mixture of equal parts of plaster and pulverized marble, with enough water to make a thick paste. After this investment has set, solder the retaining-pin and the base-plate together.

"To make the collar, a somewhat crescent-shaped piece of platinum or gold of suitable size is prepared and pressed into shape upon the palatine and palato-proximal face of the tooth; little slits may be cut in the collar with a delicate pair of scissors, to make easier this adaptation; care should be taken not to push the collar up under the gum at any point, provided the palatine wall of the tooth, which had been allowed to remain standing is at all ample in height—say one-tenth of an inch; if less than this the collar may pass under the gum for a short distance, as will be shown subsequently. In the average case this collar will not quite one-half encircle the tooth.

Fig. 172 shows the collar curved to the outline of the gum-margin and shaped to the contour of the palato-proximal wall of the tooth. At G are the slits cut in the platinum to allow overlapping in shaping to contour.

"In order to strengthen the collar and facilitate its attachment to the base-plate, cut a series of slits in that portion of the base-plate which has been made to project beyond the palatine wall of the tooth, and the base-plate, with its now attached pin, being placed with the collar in position in and upon the tooth, the little strips of metal into which the overhanging edge of the base-plate has been cut are pressed, one after the other, down upon the collar, and carefully moulded to its surface, so that the collar will no longer consist of a

single thickness of metal, but will be reinforced by these additional thicknesses of base-plate thus pressed upon it.

"Fig. 173 shows this quite perfectly: H is the free end of the retaining pin which is to be cut off when the porcelain tooth is mounted. I is the base-plate, with its overhanging palatine margin cut into strips, J, which are being pressed down upon the collar, F, by the broad-surfaced and serrated instrument, K. This being accomplished, remove the several pieces from the mouth, carefully cement the collar in its proper position relative to the base-plate, which will now form a sort of matrix for it; again place in the mouth, readjust, harden the cement, remove from the mouth, invest as before, and solder the collar and base-plate together, using a considerable

Fig. 173.

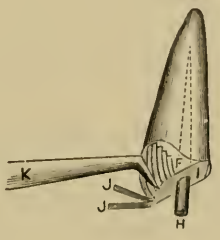


Fig. 172.

Fig. 174.

excess of solder for covering, so that the collar may be still further strengthened and its surface be made uniform.

"In cementing the collar to the base-plate, one precaution is imperative—namely, not to allow a film of cement to get between the collar and the tooth. If this is done and the investment poured in upon this film of cement, the latter will immediately burn out as soon as heat is applied, leaving a space between the collar and the investment into which the gold solder will flow, and thus interfere with that perfect adaptation of the appliance to the tooth which is necessary to a successful result.

"The mounting of the facing next demands attention. As

already stated, a plain-plate porcelain tooth is used. This must have what are technically known as cross-pins; that is, pins placed at right-angles with the long axis of the tooth. They must also be placed well up toward the cutting edge. If they are too near the neck, they will inevitably be cut out in fitting the tooth to the slope of the base-plate on which it must be mounted.

"Fig. 174 shows the form of the facing, and indicates the slope given it in fitting. The fitting process does not differ from that ordinarily employed with porcelain teeth; an impression may be taken and the work done on a cast, or the facing may be fitted to the mouth. In either case it is in the mouth that the finer and final adjustments as to height, contour, alignment, etc., must be perfected.

"This being done and the facing backed, tooth and breast-plate are cemented together, restored to the mouth, finally adjusted, removed, and soldered as before, as much gold being flowed into the angle between the backing and the base-plate as occlusion will permit.

"This artificial crown being properly finished and cemented into position in and upon the tooth, makes what the writer, from several years' experience in its use in a large number of cases, has found to be an appliance which will remain for an indefinite period without the slightest deviation from position and alignment, and which, in many respects, is almost as strong as the natural tooth, because its point of greatest resistance to pressure is placed where Nature anchors her enamel walls—namely, upon the *outside* and not upon the inside of the walls of dentine, so that in the act of occlusion the force applied by the lower incisors as they come up in position *inside* the upper incisors falls upon the *whole* thickness of the root *through the collar*, and not upon less than half its thickness through a centrally-anchored pin—a pin, too, prolonged into a lever of enormous power by its attachment to the porcelain tooth.

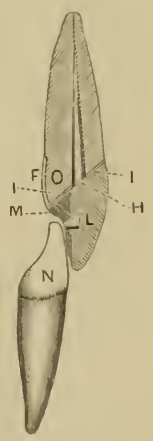
"In this respect there is a manifest weakness in all methods

of mounting artificial crowns which depend for their stability solely upon the central pin. Ultimate failure through splitting of the root is the frequent result, and the larger and stronger and more deeply anchored the pin the more certain this result, because a large pin necessitates a large opening for its reception, and a corresponding weakening of the root, upon which the strain must ultimately fall : the lever is strengthened and the point of resistance weakened.

"The only safety for the usual form of 'pivot-tooth' is, either that the occlusion shall be slight, the root very strong, or the 'pivot' very flexible or elastic. This elasticity of the old hickory 'pivot' was one of its chief excellences; roots were much less likely to split than with a rigid, unyielding metallic pin. In cuspids or incisors, however, metallic pins, unless enormously large or thickly packed around with amalgam, will very often bend outward, thus allowing a slight displacement forward of the artificial crown, and to that extent relieving the root from strain.

"Fig. 175 gives a sectional view of the collar-crown in position, the lower incisor being in occlusion. L is the porcelain facing. H is the pin attached to I, the base-plate. M is the backing and solder. N is the lower incisor, and F the collar. It is clearly evident that here the force of occlusion falls upon the palatine wall of the natural tooth at O, through the collar F, and not upon the pin at the point of its attachment to the base-plate H, and through the pin upon the thin outer shell of the root.

Fig. 175.



"In cases frequently met with, where the entire crown of the tooth has been removed, the collar, as before described, can be adapted to the palatine face of the root, provided the latter be not decayed away up to the alveolar margin. Usually, however, there is a considerable space between the

free edge of the root and the alveolus, and here, running up to the alveolus, the collar must be placed.

"The dotted line E in Fig. 171, p. 182, indicates a collar so placed. All the steps in the process are essentially the same as before described. Adapting the collar to the surface of the root beneath the gum is somewhat painful, but not excessively so, and in the wearing the irritation caused by its presence is very slight and transient in character, assuming, of course, that care has been taken to leave upon it a smooth, thin, and well-polished edge.

"The objection may be urged that this form of crown resists pressure only in one direction, from within outward, and does not provide for lateral pressure or pressure from the front. As a rule, the latter can occur with any force only as the result of accident, while if the crowned tooth is in normal relation with its fellows, and the artificial crown be closely fitted between them, they will fully sustain lateral force.

"When such lateral support is wanting, through isolation of the tooth, the collar must be extended into a ring or ferrule completely encircling and grasping the root, and thus affording support on all sides. The ring, however, is more troublesome to make and more painful to apply, and generally shows a line of gold in front. In the average case the simple collar gives all requisite strength.

"In mounting crowns upon bicuspid and molar roots, however, the ferrule principle is often essential to stability; especially is this true of lower bicuspids and molars; as here the forces applied in mastication are as erratic in direction as they are powerful in character, and the root must be guarded at every point against their violence.

"In fixing in position the artificial crowns just described, the writer prefers to use a gutta-percha cement, adhesive in character, which will not strip from the pin when the crown is forced into position.

"The apical foramen is closed, the pulp-canal grooved and thoroughly dried, the central pin is barbed, and the pin and inside of the collar and under surface of the base-plate are thickly coated with gutta-percha; the entire appliance is then heated to a temperature sufficient to thoroughly soften the gutta-percha, and firmly pressed up into position; the excess of gutta-percha will ooze out at all free margins, and may be subsequently removed with suitable instruments.

"A good gutta-percha cement will hold firmly in a great majority of cases, but when, as in a small lateral incisor, the retaining-pin is necessarily small and short, and the collar not as ample as could be desired, an oxychloride or oxy-phosphate cement, mixed thin, will be found to give greater stability. When these cements are used, however, it will be found very difficult to detach the artificial crown from the root, should it for any reason become necessary to do so; whereas, a little heat will quickly soften a gutta-percha packing and permit the entire appliance to be withdrawn without difficulty.

"There are various methods of mounting artificial plate teeth in natural roots, in which the dowels are used simply as a means of holding the tooth in place while gold or amalgam is packed into the root and built up to form the palatal surface of the fixture, this being mainly relied upon to support the tooth in position.

"These operations, especially if done with gold, are exceedingly difficult and tedious. When we consider this in connection with the fact that in case the porcelain crown is accidentally fractured, there is no way of repairing the injury without destroying all that has been done, and redoing it, I consider them of doubtful value.

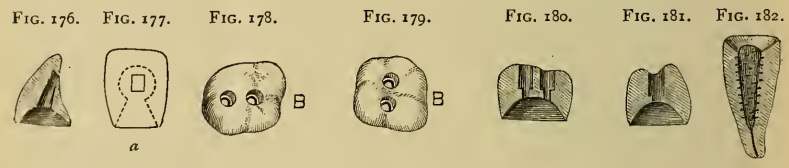
"The probability of accident is always present; I therefore regard facility of repair as practically an important consideration in estimating the relative value of any

method of replacing, by artificial substitutes, these important organs." *

The Bonwill Crown.—"This consists of an all porcelain crown with a hole through it and countersunk in the outer surface, Fig. 178 and 179 showing the molars.

"Fig. 176. Sectional view of an incisor crown as now made, from mesial side, showing the under-cut at the point opening on palatal surface, the conical base and the opening from the same to the retaining grooves, with the exact relations.

"Fig. 177. Palatal view of the same tooth: *a* is the external opening for egress of alloy and for packing around the pin; the dotted lines around *a* show the recess or under-cuts on the mesial and distal sides and near the point, for retaining the crown, and its relation with the conical base.



"Fig. 178. Grinding-surface view of a superior molar, with the countersunk pin holes on the *buccal* and *palatal* sides.

"Fig. 179. Same view of an inferior molar with the pin-holes on the mesial and distal sides.

"Fig. 180 and 181. Sectional view of a molar and bicuspid crown, showing the countersinks and their relations with the conical base.

"Fig. 182. Sectional view of an incisor root, showing the retaining cuts made by the wheel bur shown in Fig. 189.

"Fig. 183. End view of a canal prepared for the improved combination metal-pin.

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* "Am. Syst. Dent.," II, 807.

" Fig. 184. End view of same canal as in Fig. 183, prepared for a triangular pin, showing how much more of the mesial and distal surfaces have been cut away from it than in Fig. 183 for the improved pin.

" Fig. 185. Sectional view of an incisor crown and root, with the improved pin in its relative position to each, with the depressions made by wheel bur.

" Fig. 186. Sectional view of a superior molar, with the large angular pin in palatal root and two square pins in the buccal roots, one being shorter and not passing through the crown.

" Fig. 187. Block of a molar and bicuspid, showing the countersunk holes for pins in the molar and the hole in the

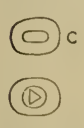

Fig. 183. Fig. 184.

Fig. 185.

Fig. 186.

Fig. 187.

Fig. 188.

Fig. 189.

mesial side of the second bicuspid where a pin is alloyed in and set into a decayed cavity in the distal surface of the first bicuspid, being held upon the molar roots and attached to the bicuspid by the alloy.

" Fig. 188. Side and end view of the largest size angular combination metal pin with the stamped serrations. The square pins are without serrations and double pointed, made of same metal and of equal thickness throughout. All the pins as now made are without serrations and of double thickness.

" Fig. 189. The smallest-sized wheel-bur for grooving the canals for anchoring the pin and alloy. No need of more than one wheel on each shaft.

"The pins are made of platinum-iridium alloy, and barbed, to hold more firmly.

"Later pins of hard metal, an alloy which will amalgamate. These do not need to be barbed, and can be pulled out more easily, if need be.

"The natural tooth is cut and ground off a little below the margin of the gum. The porcelain crown is then ground to fit the surface of the root and the occlusion of the opposing tooth.

"The root canal is enlarged, and the pin of proper size adjusted to it.

"The pin is cut the right length and bent, if need be, to support the crown in position. The walls of the canal are grooved with a wheel bur, as shown in Fig. 182.

"To set the crown the canal is partially filled with amalgam and the pin forced to place with a pair of pliers; then additional amalgam is packed around the pin until the canal is full. Then cover the pin with soft gutta percha to protect the tongue, and dismiss the patient.

"At a subsequent sitting the crown may be set, placing some amalgam on the root and forcing the crown to place, and packing additional amalgam around the pin through the hole in the crown, and filling the countersink. Smooth off the amalgam at the joint under the gum, leaving it just flush.

"A quick-setting amalgam made purposely for it is the most suitable, and should be prepared quite soft.

"The color of the amalgam darkens the tooth crown somewhat, and often produces a blue line at the joint under the gum.

"The use of oxyphosphate cement avoids this, and also sets the crown very firmly. In case the root is frail, a band may be fitted and put on, and the crown fitted into it. It, in such cases, adds greatly to its strength." *

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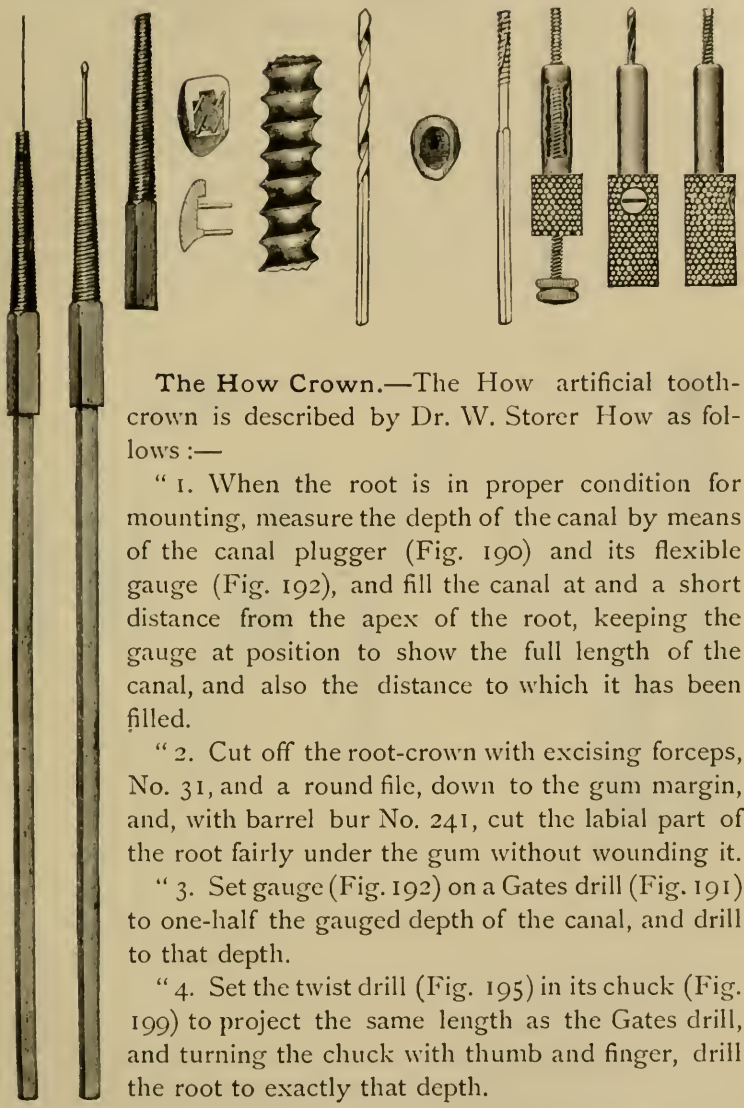
* "Am. Syst. Dent.," II, 813.

FIGS. 190, 191, & 192 FIG. 193. FIG. 194. FIG. 195. FIG. 196. FIGS. 197, 198, 199, & 200.



The How Crown.—The How artificial tooth-crown is described by Dr. W. Storer How as follows :—

" 1. When the root is in proper condition for mounting, measure the depth of the canal by means of the canal plugger (Fig. 190) and its flexible gauge (Fig. 192), and fill the canal at and a short distance from the apex of the root, keeping the gauge at position to show the full length of the canal, and also the distance to which it has been filled.

" 2. Cut off the root-crown with excising forceps, No. 31, and a round file, down to the gum margin, and, with barrel bur No. 241, cut the labial part of the root fairly under the gum without wounding it.

" 3. Set gauge (Fig. 192) on a Gates drill (Fig. 191) to one-half the gauged depth of the canal, and drill to that depth.

" 4. Set the twist drill (Fig. 195) in its chuck (Fig. 199) to project the same length as the Gates drill, and turning the chuck with thumb and finger, drill the root to exactly that depth.

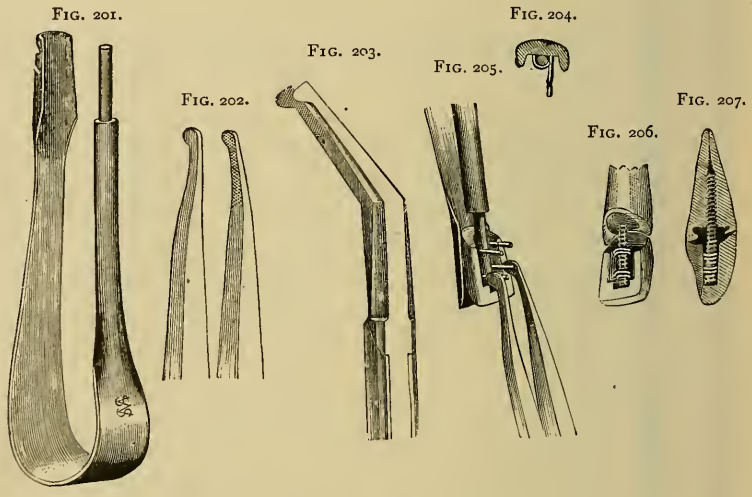
" 5. Enlarge the mouth of canal one-sixteenth of an inch deep all around to near the margin of the root, using

square-end fissure-bur No. 59, and then with oval, No. 94, under-cut a groove at sides and lingually, as shown in Fig. 196.

"6. If the rubber dam is to be used for a gold or plastic backing, put it now over the root with Hunter's root clamp, also over the adjacent teeth, and thoroughly dry the canal.

"7. Set the tap (Fig. 197) in its chuck (Fig. 200) a trifle less in length than the drill, and carefully tap to the gauge depth.

"8. Insert the post in its chuck (Fig. 198) to the exact gauge of the tap, and turn the thumb-screw down hard on the end



of the post; then screw the post into the root, release the thumb-screw, unscrew the chuck a half turn, bend the post until the chuck stands in centre line with the adjoining teeth, and unscrew the chuck.

"9. Slit the rubber back from adjacent teeth, tucking the flaps out of the way, so that occlusion may be tried, and the post excised and ground off until the teeth close clear of the post.

"10. Try the crown on the post, and with an F disk, *dry*,

grind the rib between the neck pins until the crown is labially flush with the root margin, cutting a little at a time until exactly flush.

"11. Take the crown and place the mandrel (Fig. 201) between the pins just as the post is to be, and with the pliers (Fig. 202) bend the pins carefully over the mandrel, cutting off the pins if too long to be pinched in on the mandrel at the sides, observing that the pin nearest the cutting-edge is first to be bent (Fig. 204), and the opposite pin bent *below* it on the mandrel, and so with the others (Fig. 205).

"12. Slip the crown over the post, try occlusion, and with the post-chuck bend the post until the crown is properly aligned with the teeth; then with a stump corundum wheel No. 3 grind the neck of the crown to a close labial fit with the root, fitting only the portion to be concealed by the gum, leaving narrow gaps at the sides to be filled by the backing between crown and root (Fig. 206).

"13. Grind cutting-edge for relation to the other teeth, being sure that opposing tooth does not strike crown, or post, or pins.

"14. Fix crown on post by pinching the pins into the screw-threads of the post with special pliers. (Fig. 202 or 203.)

"15. Finally, pack the backing of gold, or cement, or amalgam, or—for temporary backing while treating abscess—gutta-percha, into all the crevices around the post and behind and under the pins, and between the crown and the root; contour and finish thoroughly, so that no ledge or other imperfection can be found.

"Fig. 207 shows in vertical mid-section an incisor crown mounted; the blackened portions of the backing defining the locking-hold of the backing on the post, the crown-pins, and the root recess.

"Fig. 208 shows in perspective a cuspid crown ready to be slipped over its post, and also a cuspid crown ready for its post in the bicuspid root, which has its lingual cusp remaining,

and Fig. 209 shows the crowns on their posts awaiting the contour-backing.

"In mounting a crown on the bicuspid root (Fig. 208), the chucks will not pass the natural cusp, and hence both the drill and the tap must project the cusp's length in addition to the gauge length. Observe also if the space between the tap and the cusp is wider than the thickness of a crown-pin, and if not cut the cusp vertically with a large fissure-bur, so that the space shall be wide enough before setting the post, else the bent pins will not pass between the post and cusp. Grind the rib—see step 10—quite down to the floor of the crown; take steps 11, 12 and 13, and if the occlusion necessitates grinding the

FIG. 208.

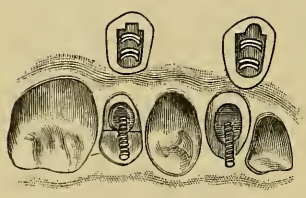
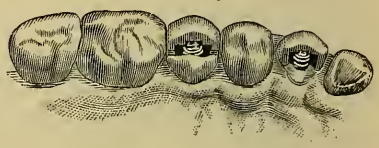


FIG. 209.



crown so as to destroy one pair of pins, invest the crown, and solder the pins at the lap, taking step 15 for completion.

"When it is desired to contour the backing of a cuspid crown to form an inner cusp, or to adapt a cuspid or incisor crown for masticating uses, the pins may be twisted together over the mandrel, and again twisted tightly over the post, as in Fig. 210; but in some cases it may be better to bend the neck-pins, as in Fig. 211, instead of twisting them. In all cases the bent pins are to be pinched quite hard over the mandrel and post, so that the serrations of the pliers will roughen the pins, to prevent their being pulled through the backing, which should also be condensed around the pins and post.

"If the root is not ready for permanent mounting, use a

tubular post, or in the absence of a threaded tube, take the successive steps up to 13; then back temporarily with wax, rubber, or gutta-percha, awaiting the next sitting, when the crown may be taken off, the post unscrewed, and the remedy applied. Thus the root may be alternately medicated and mounted until ready for the permanent crown.

"When the root is much decayed, the bottom of the cone-shaped cavity may be drilled and tapped to the depth of a sixteenth of an inch, and the post, thus anchored, may be further secured by cement in the grooved walls of the cavity and around the post (Fig. 212).

"These crowns afford unusual facility for mounting by any

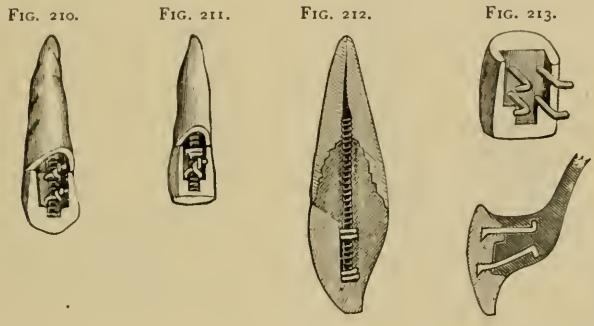


FIG. 210. FIG. 211. FIG. 212. FIG. 213.

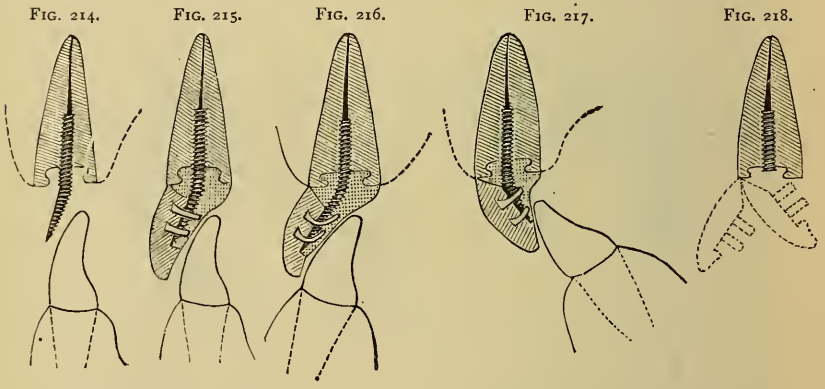
of the well-known methods of inserting the post, after soldering it to the crown. They are also adapted for use in celluloid and rubber work, especially in cases of single teeth. The several long pins, having their ends bent with pliers at a sharp angle (Fig. 213), may be so arranged as to both strengthen the shank of the plate and hold the crown very firmly in position.

"The screw-posts are made of crown metal, an alloy devised for the purpose in order to obtain a stiff post that will permit the cutting of the peculiar and extremely accurate thread formed upon it, and which will not amalgamate or be otherwise affected by any backing-material that may be used. Of

course platinum or platinum alloyed with iridium may be employed for posts, but the crown metal is in every way superior.

"There are some cases of a class which has hitherto presented difficulties that may not be easily overcome by grinding the post flat on the crown side after it has been set and bent in the root (Fig. 214), so as to be clear of the occluding tooth; and then the crown-pins may be bent over the reduced post, the crown fitted and ground to clear the opposing tooth (Fig. 215), and the backing added.

"A similar case, in which the opposing tooth and a proper



alignment require an oblique bending of the pins, is seen in Fig. 216, while the reverse arrangement of parts is shown in Fig. 217. The crown is thus seen to be adapted to a wide range of adjustments because its point of contact with the root is at the labial portion of the neck, on which as on a hinge the crown may be swung out or in (Fig. 218, dotted lines), over an arc of at least sixty degrees, at any point of which it may be quickly and firmly fixed. The labio-cervical junction is made just under the gingival margin, and I usually interpose a thin layer of cement, amalgam, or gutta-percha, or a narrow ribbon or several large blocks of soft gold; the joint always

to be made smooth, and hid from view under the free margins of the gums.

"The obviously great advantages of such a plan led to the adoption of a single size for post and appliances, but a second size has been proved to be a necessity, and hence the B size is now designed for superior centrals, and cuspids, while the A size is used for laterals and bicuspids, as also for all the inferior roots anterior to the molars. The handles of the tap-chucks and post-chucks are made of small diameter to insure that too great force shall not be used with the thumb and finger in turning in the tap and the post; and it is enjoined upon the operator to remove the tap when it begins to turn at all hard, and repeat the removal until it has been easily turned down to the gauge depth. The cuttings must then be carefully blown or wiped out, so that the post may be easily turned down to the bottom of the hole without risk of splitting the root, as there is danger of doing with too great force acting on the *débris* as a wedge—hence this caution to employ only a reasonable amount of force and to do thorough work. The disk for grinding the crown-rib is an essential part of the equipment, and when the engine is not at hand, may be used in the lathe by means of lathe-chuck No. 8."

Baldwin's Crown.—"The modus operandi is as follows: Select a Logan crown slightly shorter than would be used for setting without a ferrule. Countersink, and prepare the inside of a root as for a Bonwill or any ordinary crown. If the outside of the root at the margin of the gum presents an irregular surface, then with Dr. Walter Starr's reducers shape it to such a size that the ferrule may be perfectly adapted to all parts. Then take an impression, and produce in zinc or Babbitt metal a die, to form which take a plaster model of the root end an eighth of an inch long, and shellac it to the point of a cone, which can be easily made by turning down a large spool, thus making the deep mold in sand, into which the metal is poured. With this die strike the gold (twenty-two carat, No. 30 gauge, is most commonly in use) laid upon soft lead. A

few blows will produce a seamless and perfectly-fitting cover and ferrule. After trimming this to fit the festoon of the gum, drill in it from the lower side a hole for the pin of the crown, leaving the ragged edge produced by the drill. Then fill the countersunk portion in the porcelain crown with oxyphosphate of zinc, and with the gold ferrule or cap in place adjust the crown as you would wish it when completed. When the oxyphosphate is hard, you will find the ragged edge on the upper side of the cover will materially aid in removing and keeping the cap where it belongs. Unite the cover to the platinum pin in the crown with a small amount of soft solder

FIG. 219.

FIG. 220.

FIG. 221.

—tin and lead—using muriate of zinc as a flux, a few blasts from the blowpipe being all the heat required. Then fill the root with oxyphosphate and firmly press to place. These caps might be made up at leisure, providing a few variations for double and single-rooted teeth. When a case is met that you cannot fit from your stock, choose a cap larger than the end of the root, and with a single clip of the shears cut to the centre of the cap, and with pliers spring together and lap the edges until the size required is obtained. Solder with gold solder by holding over the spirit lamp and proceed as before. Fig. 219 shows a root cover and Logan crown ready to be

assembled for the soldering of the crown-pin to the cover; Fig. 220 shows the cap cemented and soldered to the crown; and Fig. 221 the completely crowned root." *

FIG. 222.

Low's Crown.—In our first cut, Fig. 222, we present seven instruments. No. 1, the smallest, will be used most frequently.

* *Cosmos*, XXIX, 19.

Any tooth generally considered beyond restoration can be crowned with this instrument.

"We now have before us in Fig. 223 a central incisor badly decayed. There is little tooth-substance exposed below the margin of the gum, the little remaining being the outer walls. The first step to be taken to place on this root a strong and serviceable crown is to cut or grind even with the gum what tooth-substance remains. We start off with the supposition that the root is in a healthy condition; if not, it must first be treated and made so, as this is the first consideration in the final result of a successful operation. The next step is to select the instrument in accordance with the size of the opening in the root to be crowned. The larger the opening in the root the larger the inside or centre cutters must be, and the narrower the cutters that bevel and prepare the end of the root. The reason for this is that the space is nearly all taken by the inside cutters in order to reach and cut away the decayed tooth-substance, and prepare the root to properly receive the step-plug with bevel cap which covers the end.

"We have seven sizes of instruments, and if the right one is selected, no tooth-substance will be removed that ought not to be, cutting, as it does, the least where the tooth is smallest, or, in other words, we cut the opening in the tooth tapering to the shape of the root.

"These cutters leave the root in the shape of Fig. 224, with graded steps.

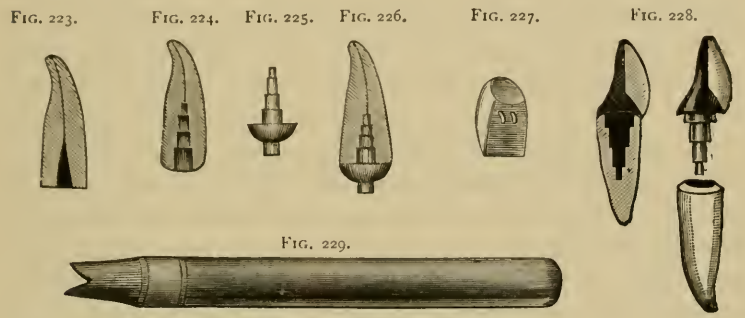
"We next select the graded step-plug seen in Fig. 225.

"This is the same size as the instrument, and will perfectly fit the opening and cover the end in a beveled saucer shape, and by its attachment to the inside step-plug when cemented make a combined union of great strength, and so made as to be impossible for the root to split. Fig. 226 shows the step-plug placed in position.

"After placing the plug in position, an articulation of wax and impression of the space to be supplied and of the adjoining teeth are taken in plaster-of-Paris. Before taking the

impression be careful that the pin which extends from the cap of the step-plug for purpose of removing is free from all roughness (a roughness that is sometimes left in the cutting of the plug), as this is liable to break the plaster when removing the impression. I generally fill the step-plug on a slant from the labial side to the centre, so that there shall be no mistake in replacing the step-plug in its proper place in the impression.

"After placing the plug back in the impression, if necessary, take a thin, heated spatula and stick the plug fast with a little hard wax on the outer edge so that it may not be disturbed in pouring.



"Be careful not to get any wax on the part of the plug where you do not want solder to flow in. Now varnish the cast as usual, but do not touch the plug with varnish. Next pour with plaster and sand, asbestos or pulverized pumice-stone, any one of which will do. After the plaster is thoroughly hardened, cut it away in the usual manner. Place the articulation in the articulator and pour in the usual way. The tooth is selected, and we proceed to back it in the following manner: First grind and fit the tooth to the cast and cap to suit you; then cover this entire inner surface with thin platinum, the thinner the better. Burnish close to the surface of the tooth. Then use 28-gauge platinum for a backing down to where the

tooth is ground out to fit the step-plug, and bend the pins down to hold the two pieces of platinum tight to the tooth. We now have Fig. 227, representing the tooth as it appears backed ready to place in position.

"Next place the tooth in position, in the cast, cover with plaster and sand and solder with coin gold. After finishing and polishing the crown is ready for adjustment. Moisten the step-plug and cap with cement, as in Fig. 228, and with the little roller, seen in Fig. 229, gently press the crown up in position, and we have the crown completed as seen in Fig. 228.

"If you desire a cheap crown, solder with block tin. After experimenting with various metals, I have succeeded in making a step-plug—or tip, as I usually call it—of platinum and nickel, that is as strong as steel, and cannot be melted.

"If I perfect the crown myself, I take a shorter way: After preparing the root with the instrument, and placing the step-plug in position, my tooth is selected, ground and arranged in the mouth, after which I back the tooth as before described. I warm and stick to the backing of the tooth a small amount of sticking-wax, made of rosin, gutta-percha and beeswax, and place the tooth in position in the mouth, perfectly imbedding the top of the step-plug in wax. Great care must be exercised to have the tooth in the position desired, and in pressing the tooth and wax against the plug. I next carefully remove the wax and tooth, and with pliers remove the step-plug and place in the impression just made. Then with a heated spatula I stick the tip and wax together, pour in the usual way, and in a few moments it is ready to solder. Thus a tooth can be set easily in one hour's time.

"To crown á bicuspid or a molar, your first step is to grind the tooth-substance even with the margin of the gum, and then use your drill. In drilling, instead of following the nerve-cavity direct, which would leave the instrument a little diagonal, hold the instrument perpendicular. This leads the upper portion of the drill to the outer wall of the root and brings the lower portion of the drill to the inner side of the root.

"You would puncture the wall of the root if you went deep enough, but there is no need of going to such a depth. Next take No. 1 cutter, which will invariably be the instrument to operate on all the bicuspid and molar root-canals, and after carefully cutting to the depth desired, the root is ready for the introduction of step-plug of same size. We now drill one other root in the same manner, and after placing the step-plugs in position, take an articulation and impression, remove the plugs and place in the impression, pour and separate and place in the articulator as before described. We have with the adjoining teeth an exact impression of the root to be crowned.

"Next take a thin piece of platinum and make two perforations for the pins on the end of the step-plugs to enter, press the platinum down over the root and burnish close to it; then remove and trim by the marks made in burnishing to the exact shape of the root.

"Place the platinum on the root again, and we are ready to select our tooth. This should be made the same as is used for bridge-work, with gold cusps, so no breakage can possibly occur. Place the tooth in position in the articulator and hold in place with wax. Encase in plaster and sand, and fill in and solder with coin gold, or, if you choose, block tin can be used. After polishing and burnishing, you have a strong, durable crown, ready to be adjusted, only equalled by the natural tooth.

"In setting a bicuspid, we seldom use more than one step-plug, and the process is similar to setting a molar.

"Fig. 230 shows the root cut ready to receive the step-plug. Fig. 231 shows us the step-plug with the platinum covering the entire tooth-surface. In Fig. 232 it will be seen that the cap to the step-plug goes below the surface of the tooth, leaving tooth-substance all the way round, but the platinum that is soldered, to the step-plug rests on the tooth-surface. In Fig. 233 we see the crown ready for adjustment. Fig. 234 is the tooth after it has been adjusted.

"These plugs can be used to great advantage in varied dental operations. There is nothing equal to them for restoring broken and decrepid teeth to their original shape, appearance and usefulness. I use them exclusively in bridge-work. They make a firmer, stronger and more durable groundwork for bridging than any other method I have ever discovered.

"In badly decayed molars, where there is not sufficient tooth-substance to hold a gold crown for a bridge, I always stick one of these plugs in the root to constitute a solid foundation. If the pin on the end of the plug for removing is not long enough, it can be very readily lengthened by soldering a piece to it, and this without danger of injuring or melting. The plugs are made of a perfectly non-corrosive metal,

FIG. 230. FIG. 231. FIG. 232. FIG. 233. FIG. 234.

though the color might indicate otherwise. They are strong as steel, and cannot be melted by any heat from an ordinary blowpipe."*

The Improved Richmond Crowns.—"The pivot is baked into the crown. Prepare the root and adjust the tooth-crown to place. Fill the root with cement and insert the pin of the crown, leaving an open joint. Pack amalgam between the crown and root, making a perfect joint.

"Another. Combine with the band and cap a tube, which are secured to the root with cement; into this tube the pin of the porcelain crown is cemented with gutta-percha dissolved in ether. This may be used for bridge-work. The supporting

* "Am. Syst. Dent.," II, 905.

roots are fitted with bands, caps and tubes the same as for a single crown.

"A pin is attached to each end of a bridge-piece, and these pins are slipped into the tubes and cemented with gutta-percha, or may be inserted without cement. Such cases are easily removed."*

Meriam Crowns.—Dr. H. C. Meriam constructs an all porcelain crown similar to the English tube teeth shown in Figs. 235 and 236.

FIG. 235.

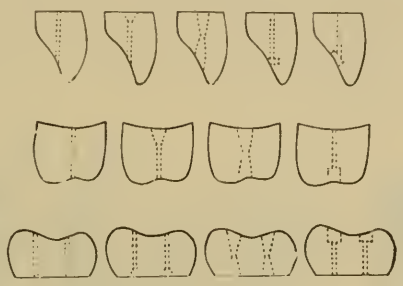


FIG. 236.

They are much stronger than those customarily used. He sets them in a band which is fitted to the root and crown, and dowels may or may not be used in the root. Gutta-percha or cement may be used to set them.

"The band is fitted to the root and the crown ground into the band after proper occlusion with its antagonist has been obtained. If a molar, a fine groove is ground around it, and the band, after being corrugated on its inner surface with a small bur, is placed on a lead anvil and the tooth driven into

* *Cosmos*, XXVI, 369.

it, thus partially securing the advantage of union by gomphosis. The common glass stopper is a good illustration of how little more than its fit would be required to retain it firmly in place. For this little I have drawn on the tube-teeth workers of England. A few small pieces of sulphur are then placed inside the band and all held over a small flame until the sulphur melts and flows into the groove between the band and the crown. Zinc phosphate may be used before the crown is forced in, or some flux, borax, for instance, which melts at a low temperature, though this would probably require investing. We then have a crown which, if a molar, I do not fear to attach with gutta-percha without dowels; but others may not have this confidence, and dowels may either be put into

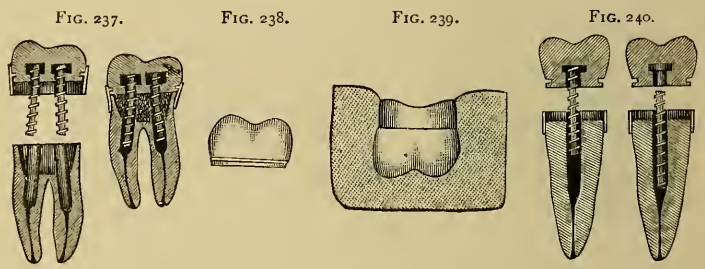


FIG. 237. FIG. 238. FIG. 239. FIG. 240.

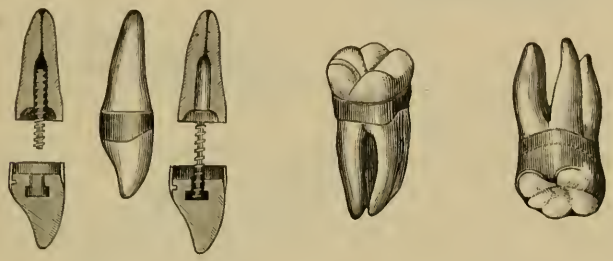
the roots or be set in the crown with cement, and afterward screwed to their places in the root as usual (Fig. 237). It is evident that if cement is strong enough to hold a dowel, it must be equally serviceable in securing the crown to the dowel. If greater security is desired, a fine platinum or pure gold wire may be fitted into the groove around the crown (Fig. 238). Drive in as before; invest and solder (Fig. 239). For the incisors the groove should not run around the anterior face of the crown, and I have not soldered those teeth in (Fig. 240). I have entire confidence in any form for the incisors and bicuspids where the root is well banded, the dowel put into the centre, and the crown forced into place in gutta-percha (Fig. 241); while for the molars, if quite short I do not care for the

dowels. You will notice that this method does away with much of the showing of gold in molars where such a result is desired (Fig. 242).

"Another form for molars, although it shows more gold than the others, is perhaps stronger. The band is made full width down to occlusion, and any large, strong tooth is ground to fit the space in the arch. This is driven into the band so as to be even with its edge, and cemented with sulphur as before (Fig. 243).

"*Setting.* I first varnish the band inside with Canada balsam dissolved in ether; then fill the crown with gutta-percha and crowd it up against the root several times to get an impression.

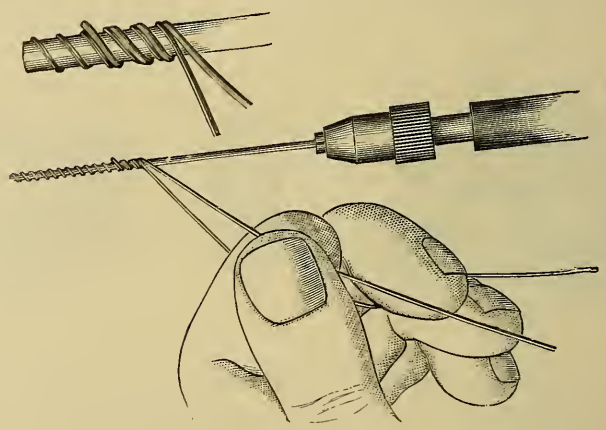
Fig. 241. Fig. 242. Fig. 243.



When sure that I have the right amount of gutta-percha, I place the dowels in the root (if I am to use them), heat the crown, dip it into cajeput or any essential oil, and crowd it to place. The dowels I fit in the same way, wrapping them with gutta-percha and working up and down in the root until I get the impression before the final forcing to place. I thus have the advantage of the dowel and hard centre of gutta-percha to act as a plunger, and the soft semi-dissolved gutta-percha comes back on the outside of the mass, forming, I think, the tightest root-filling known. I fill roots in this way with gutta-percha points when I do not use a dowel. The dowels used are made by wrapping a piece of platinum and iridium wire with about one-third of a sheet of gold-foil, which is melted

on, and the combination made true by being drawn once through a wire-gauge. A piece of piano-wire is then wound around it three or four times to serve as a guide, and a fine platinum wire, previously drawn square, is caught and turned through the wire-guide a few times, when the winding may either be finished by hand or the end, after being started, may be placed in a lathe-chuck and wound up at once (Fig. 244). A piece of gold foil is then wrapped around the whole and the fine wire soldered on. A dowel made in this manner is not strained by having its thread cut, and the thread being square

Fig. 244.



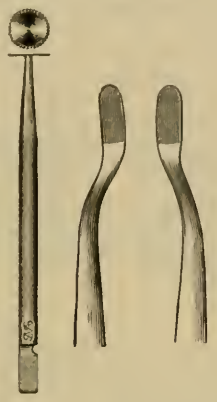
and coarse or fine, as you wish, is strong and possesses plenty of grip.

"When a root has broken off far under the gum, it should be filled with gutta-percha and a temporary plate worn—if the loss be in the front of the mouth—until it works down, when it may be crowned and the plate given up.

"In preparing roots after a large portion of the crown is broken away, I enlarge the pulp chamber with a large, round bur, and, when even with the gum, follow with the revolving saw here shown (Fig. 245). With this saw I often cut off the

remnants of a crown from the inside without wounding the gum or drawing a drop of blood, and am saved the unpleasantness of running a stump corundum wheel in the mouth.

Fig. 245. Fig. 246.



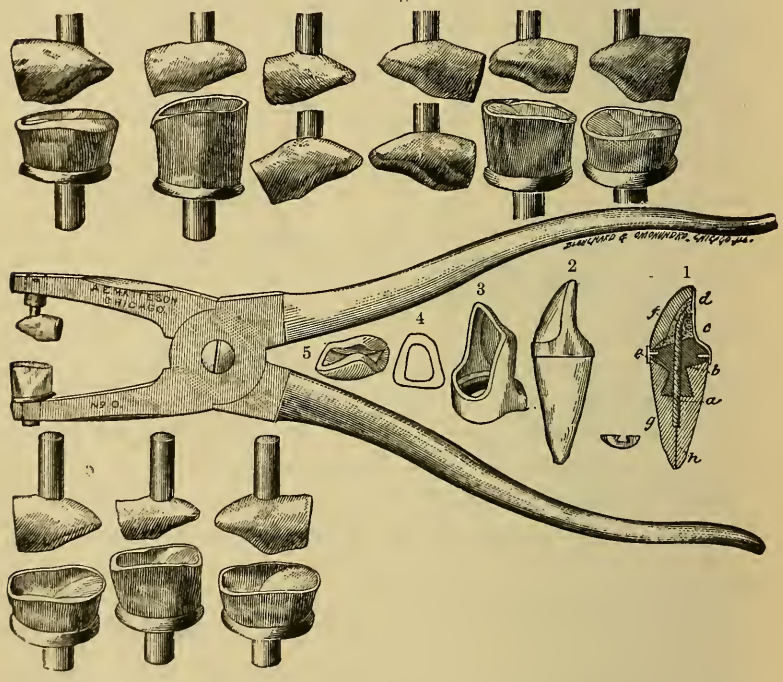
"The outside of the root can sometimes be formed with the instruments here shown"* (Fig. 246).

The Mattison Crown.—"The root upon which the crown is to be mounted should be placed in a healthy condition, with the pulp-canal filled at the apex, the end ground off below the free margin of the gum in front and within an eighth of an inch of the gum on the inner or lingual surface, the end of the root countersunk, and the pulp-canal enlarged sufficiently to receive a platinum wire—No. 18 or 20, standard plate gauge—with a screw-thread cut thereon. This should fit tightly enough to take firm hold. Further, enlarge one-half the length of the pulp-canal with a cone-shaped bur with its base toward the apex, as represented in No. 1 (Fig. 247). Previous to grinding the end of the root below the gum in front, with fine binding wire take a measurement of the circumference of the root at the margin of the gum. Cut across

* See *Cosmos*, XXVIII, 493.

at intersection, and carefully remove the wire ring thus formed, without changing its shape. Take an impression of its form, by placing it between a sheet of writing paper and a smooth surface, and by rubbing the end of a finger thereon the outline will appear. This is the outline of the end of the root; from this cut a pattern. Dissect the gum from the end of the

Fig. 247.



root up to the alveolar process. Select a die (forms shown in Fig. 247) similar in shape to the root you wish to reproduce. Make a pattern of the shell by pressing between the dies a piece of pattern tin, leaving an opening in front as represented in No. 3 (Fig. 247), the cut being on a line with the edge on one side. Remove this pattern and press into as plain a surface as possible without stretching the margins.

"Cut the gold-and-platinum plate to pattern, making it wider or narrower as the wire measurement of the end of the root compared with the pattern indicates. Anneal and place the plate in the same position between the dies as that previously occupied by the pattern, and press into form; remove, bring the edges together without lapping and solder with pure gold. The shell may be made longer or shorter, wider or narrower, than the die upon which it was made, as the case demands.

Fit the shell to the root; trim the root end of the shell until it occupies its proper position and the articulation is correct, which is determined by the patient closing the teeth. The corners at the cutting edge and sides should be cut and the edges brought together without lapping, and also soldered with pure gold.

Then from platinum plate, No. 28, cut the ring, No. 4 (Fig. 247), to the proper pattern. This forms the shoulder within the shell (the opening in the ring may be cut out with a plate punch). Place the shell in position on the root, the teeth closed; insert the ring, which should rest upon the end of the root midway the width of the band in front, and should fit the shell so tight that both can be removed without changing their relative positions. Remove from the root, and with a fine camel's-hair apply borax finely ground in water. At the junction of the two pieces place a small piece of twenty-carat solder on the inner surface, *i. e.*, toward the cutting edge of the shell, to prevent an excess of solder flowing between the shoulder on the end of the root upon which it will rest. Flow the solder, which should merely tack the ring in place at the front. Try upon the root to make sure of its being correct; remove and complete the soldering.

"The shell may be strengthened by flowing inside a lower grade of solder than previously used at such places as desired.

"Select a plain rubber tooth and fit it to the opening in the shell (which may be removed for the purpose), and with a corundum wheel and disk grind a dovetailed slot in the back (see No. 5, Fig. 247), running lengthwise, and sufficiently

deep to permit the platinum screw to extend two-thirds the length of the crown without interference.

"*To Anchor the Crown to the Root.*—Place the shell in position; apply the rubber dam over it and the adjoining teeth, turning the edges well under the gum; remove the shell; the dam will remain in position.

"Dry the pulp-canal, insert the wire screw, cut it off the required length, and with amalgam mixed hard fill around the screw in the root, and covering the end, again replace the shell on the root (the end of the screw should be bent against the inner wall of the shell when the teeth are closed, so as to fall into the dovetailed slot in the porcelain front when that is inserted). Continue the amalgam filling through the opening in the front of the shell, around the screw and over the shoulder, as represented in No. 1 (Fig. 247); and with oxyphosphate cement complete by filling around the wire and in the slot of the front, which is then inserted and pressed into position between the thumb and finger, the excess escaping at the edges.

"Burnish the edges of the shell around the neck of the root and porcelain front. Instruct the patient not to disturb for from four to six hours." *

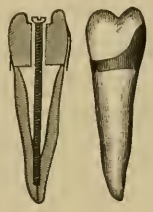
Dr. Kirk's Crown.—"The root is prepared in the usual manner by carefully closing the apical foramen with gold or gutta-percha, and removing all softened dentine from the canal, which is then undercut or roughened with a wheel-bur. The apical end of the pulp-canal is enlarged by a drill, and a thread cut in the dentine by means of one of How's drill taps. Only a small portion of the upper end of the canal is so tapped, just sufficient to engage from a sixteenth to an eighth of an inch of the end of the screw-post, as dependence is placed mainly upon the cement lining for anchorage. A collar of 22-carat gold, No. 30, having its edges smoothly bevelled, is accurately fitted to the end of the

* "Am. Syst. Dent.," II, 932.

root and driven tightly on to it, until it extends somewhat over one thirty-second of an inch under the gum. The collar is cut short upon the labial side and left long upon the lingual side, so that it extends nearly to the grinding surface of the lingal cusp of the finished crown, but is visible only as a narrow band upon the buccal surface at the gingival margin.

"When the band has been satisfactorily adapted in the manner described, a Foster crown, which has been previously adapted to the end of the root by careful grinding, is adjusted inside the root-collar. The crown selected should have a greater circumference than the end of the root, so that by grinding it down somewhat conically on its lingual and proximal surfaces, it can be tightly adjusted to the collar.

FIG. 248. FIG. 249.



"If a crown smaller than the collar is taken a tight joint cannot be made. When the crown has been carefully fitted to its place, a tight joint secured, and the proper occlusion obtained, a gold screw with a head upon it, similar to the ordinary gimlet-pointed wood screw, is passed through the central opening in the crown, carried up until it engages in the dentine at the apical end of the root, and driven home with a small screw-driver, and its proper length adjusted so that it firmly holds the crown and band in their proper relations to the root, as seen in Fig. 248.

"When all has been satisfactorily adjusted, the screw and crown are removed, and the root-canal, band and surrounding parts thoroughly dried; the crown is to be permanently

attached by filling the root full of slow-setting oxyphosphate of zinc mixed rather thin; the crown is then pressed firmly into its place, when the excess of cement will flow through the central opening in the crown; the gold screw is then to be pressed through the crown and driven quickly to its seat by the screw-driver, all excess of cement passing out as before through the central opening of the crown and alongside the screw.

"After the cement has hardened, all excess is cut from around the screw head by means of an excavator, after which the screw-head is covered and the countersunk opening in the crown filled with gold, anchorage for the fitting being obtained by cutting a groove around the base of the screw-head by means of a small wheel-bur. The completed operation is shown in Fig. 249."*

The Leech Crown.—"Prepare the root with a stump corundum wheel, and drill it out three-eighths of an inch in depth, of a diameter of about No. 16 standard wire-gauge, enlarging it at the bottom, as shown in Fig. 250. Now fill the canal in the root with gutta-percha or oxychloride of zinc,

FIG. 250. FIG. 251. FIG. 252.

make a gold tube to fit nicely the aperture in the root, about three-quarters of an inch in length, so that it can be more easily handled subsequently; adapt a plate of gold or platinum to the face of the root; cut a hole in it to correspond to the

* "Am. Syst. Dent.," II, 774.

size of the tube; insert the tube; set the plate over it; adjust it to the face of the root; hold it in position by any suitable cement; remove the tube and plate and unite them by solder; insert again in the root, and adapt a plain plate tooth, with a gold backing, holding it in position with a little wax or cement. Now remove the tube, plate and tooth together and solder the tooth in place, as shown in Fig. 251. Then, with a small separating file or saw slit the tube in two or more places for about two-thirds of its length; finish up the back of the tooth, cutting away the superfluous tubing. Now place a thin sheet of gutta-percha on the upper surface of the plate—that which is adapted to the face of the root; warm the tooth and plate over a spirit lamp, and press it up against the root. The gutta-percha will thus hold the artificial crown temporarily in position, and, covering the whole face of the root, make a perfect joint, shown as completed in Fig. 252. With a straight plugger fill the tube with gold or tin foil, condensing it so as to spread the split tube to correspond with the cavity in the root. The tooth is thus dovetailed into the cavity, so that it is almost impossible that it should become loosened, the filling of the tube making it almost equal to a solid gold wire.

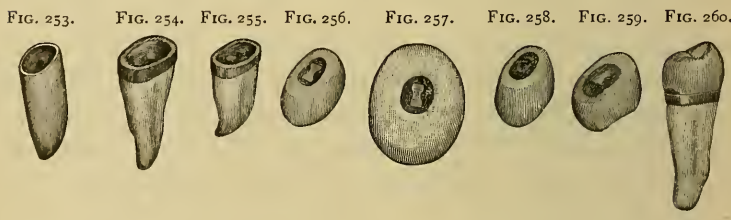
"The advantage of this method consists in the certainty which attends each stage of the operation, no guess work about it, no screws to become loose. The tube so fills the entire cavity of the root that there is no waste motion, allowing it to work loose."*

The Stowell Crown.—I countersink the end (Fig. 253), using for that purpose a large, round bur in the engine. I now make a closed cap, using the combination crown metal, and place it upon the root. The cap is then perforated and the root reamed for the dowels. The bite in wax is now taken, after which the cap is burnished into the countersunk end of the root (Fig. 254). The dowels of platinum and iridium wire are now set in their places, being allowed to pro-

* *Cosmos*, XXI, 232.

ject one-fourth of an inch, so that they may adhere to the impression of plaster, which is then taken. From this a cast is made, of investing material—calcined marble-dust and plaster is preferable, though fine moulding sand will do. The dowels are now cut off even with the top of the cap (Fig. 255).

The tooth to be used may be a Logan or an E. Parmly Brown crown, or a common countersunk tooth, but I would in most cases recommend the Logan crown. As the case in question is a bicuspid, I have selected for it a Logan crown. First, I cut off the pin, and then the tooth is ground into position on the cap, grinding the stump of the pin and porcelain alike evenly and smoothly. The stump of the pin is now ground, with a small wheel, below the surface of the porcelain



(Fig. 256). The tooth is now invested (Fig. 257), and pure gold fused on to the platinum pin, and while in a fluid state it is with a wax spatula spatted down flat (Fig. 258). The gold is now filed or ground down even with the porcelain, and at the palatal border the tooth is ground to bevel back until the gold is reached (Fig. 259). The tooth is now fastened in place on the cap with wax cement (Fig. 260), the cast cut away, and the case invested in asbestos and plaster (Fig. 261). This is used because of the fibre of the asbestos, which prevents the separation of the crown and cap. The case is now heated until the wax has melted and burned out; a small clipping of thin platinum plate is crowded into the opening (Fig. 261) caused by the grinding of the bevel on the crown. The clipping of platinum serves as a lead for the solder, which

follows it down into the countersunk cap, around the ends of the dowels, and finally attaches itself to the pure gold already firmly attached to the stump of the platinum pin. When cool the case is removed from the investment, dressed and polished, and the work is done (Fig. 262). A sectional view of a like tooth (Fig. 263) shows the organization in detail.

Fig. 264 shows a central incisor root on which a Logan crown is used after my method. Fig. 265 shows how delicate an operation of this kind may be performed upon an inferior central incisor, by the use of the countersunk tooth crown, which is shown as it appears before gold has been melted in its cup around the pin, A, when the cup has been filled with gold, B, and after the crown has been ground and beveled, C.

Fig. 261. Fig. 262. Fig. 263. Fig. 264. Fig. 265. Fig. 266.

A countersunk molar crown is shown as likewise mounted on the roots of a superior left second molar (Fig. 266).

The cuts are made from photographs of prepared specimens, the natural roots of which vary in the several figures, and in the section (Fig. 263) the continuation of the pulp canal does not appear, because obliterated in preparing the section.

The claims for this method of crown work are as follows: The combination of an all-porcelain crown with a closed cap and dowels, the adaptation of which crown and its final attachment to the root can be made perfect.

The dowels may be set at any angle that the direction of the root canal may indicate, using one or more dowels as the case may require, and when the root has to be cut off much

below the gum, and a collar cannot be placed, a platinum disk floor on the root end is the preferable plan. The well-known and easily detected plate-tooth having a gold backing which renders the tooth dull in appearance is thus made obsolete, for this crown possesses the translucent appearance of the natural organ. Best of all, the glaring gold of which some so-called beautiful crowns are almost entirely composed is by this means superseded. I hereby refer to gold bicuspids and molars, more especially to the former, which have always been an eyesore to me, and it was the unsightly appearance of these which first led me to try and improve on them.

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* *Cosmos*, XXIX, 642.

BRIDGE WORK.

Bridge work seems to have passed the stage of experiment and to have been established as one of the useful and desirable operations in dentistry. It consists of false crowns supported in the place of extracted teeth, independent of the gums, by roots adjoining the space to be filled. The supports, properly called abutments, may be on the back teeth, cap crowns, or a bar fitted into a cavity of the tooth and secured by filling; if a front tooth, a Richmond collar crown, or an open cap, as in Fig. 267, made by cutting out the front

FIG. 267.

of a cap, leaving only a narrow band at the neck. This, if skillfully adjusted and finished, closely resembles a gold filling. Such caps may be applied with success to bicuspid and cuspid teeth. They are oftenest required on the cuspids.

The cuspid crown should be dressed down until of uniform size with the neck of the tooth. Fit a band, as wide as the length of the crown, of 20-carat No. 31 gold, closely to the neck of the tooth, and solder. The palatine portion will stand away from the tooth; into this space place a piece of No. 31 pure gold and fit it to the palatine surface of the tooth, secure it with wax cement, then invest and solder to the band. Grind off the surplus from the palatine surface, and cut out the labial surface as directed, when it will be found to fit very perfectly if carefully done.

The band may be made of pure gold, thin, and fitted with

the pliers and burnishers to the crown, carefully removed and filled with strong investment, and then covered with a second layer of gold of coarser grade, and soldered. Very thin platinum may be thus used, and a very perfect fit obtained. Some obtain an impression of the crown by use of the thin platinum, and from this make a metal die and strike up a cap upon it. Skilled operators obtain very accurate fits in this way.

Bicuspid teeth may be neatly fitted with an open cap, and have the lingual cusp covered with pure gold. When the cap is finally adjusted with the cement, the edge of pure gold may be burnished down to the surface of the tooth, and it will remain in perfect adjustment. The cusp and that of the opposing tooth may be ground a little to compensate for the thickness of the gold.

In the cases above described the bands are expected to be accurately fitted to the festoon of the gums, and to pass a little way under, so the gum will completely cover the edge.

Sometimes it is more desirable to cap the teeth without dressing down, and also not to have the cap reach the gum, leaving the neck of the tooth fully exposed.

Many patients will avail themselves of the benefits of bridge work, if they do not have their teeth ground away, who would not otherwise do so.

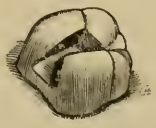
For such a case, make a band of pure gold, reaching nearly down to the gum, cover the grinding surface, as in other cases, and a band of thin 22-carat gold outside the pure gold band, but narrower, leaving a free edge of pure gold, which may be burnished down around the crown when it is finally adjusted with the cement. Fig. 268 shows such a cap, *a* being the pure gold and, *b* the thickened portion of the cap.

FIG. 268.

The bar anchorage is made as follows: "A slot for the bar must be cut in the grinding surface of the crown. In a large percentage of cases a crown cavity will be found in molars; this affords a convenient point for starting the slot. Frequently, but little more is necessary than the

enlargement or elongation of the cavity in the mesial direction. When it is necessary to start the excavation *de novo*, it is best accomplished by means of a small corundum disk, which will rapidly make an elongated cut through the enamel, thus rendering the subsequent cutting comparatively easy. The slot need not necessarily be more than one-eighth inch long, although one-fifth inch is a better length; its depth will depend upon the position of the pulp chamber, the sensitiveness of the tooth, the strength of its walls, and the nature of the occlusion. Its width should not exceed one-tenth of an inch, and may be less. The lower second molar tooth is frequently so much tilted in a forward direction that there is quite a considerable space between it and the mesial portion of the grinding surface of the antagonizing upper molar. In such cases quite a thick bar can be placed in position and allowed to rise above the general level of the tooth upon which it rests, the slot being made only deep enough to secure its proper anchorage. Where the bite is very close at all points, the slot and bar must be sunk deeper. The slot should be dovetailed and undercut, as seen in Fig. 269. The anchorage-bar should be made of platinum alloyed with iridium, and should correspond in shape to the slot, but be made as much smaller as may be necessary to afford space for packing around it, with very fine instruments, either foil, amalgam, or cements for anchorage purposes. Fig. 270 shows a desirable shape for the anchorage-bar in the case under study. The notch on its surface, filled in with a strong packing, will fully counteract any tendency to movement in a forward direction which might otherwise be manifested in wear."*

Fig. 269. Fig. 270.

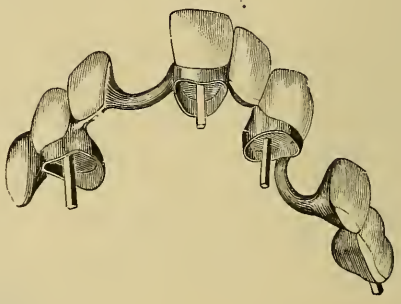


Another manner of connecting false crowns, when a natural tooth intervenes, is by *connecting bands*. They are made as follows:—

* "Am. Syst. Dent.," Vol. II, p. 846.

Fig. 271 illustrates this device for obviating the necessity for removing the crowns of natural teeth in preparing the mouth for bridge work. Crowns are fitted in the mouth to the points of attachment in the usual manner. An impression is taken, bringing the crowns away in their proper positions. From this the cast or model is obtained. Heavy bands of half-round gold or platinum bars are now fitted around the necks of the natural teeth, on their lingual surfaces. These bands being waxed in position, serve to connect the different parts of the bridge, uniting them in one piece without the loss of any of the natural crowns. I have found this a highly satisfactory method of inserting extensive pieces

Fig. 271.



of the work. Fig. 272 shows the mouth as presented, for which the piece shown in Fig. 271 was constructed. Fig. 273 shows the piece in position." *

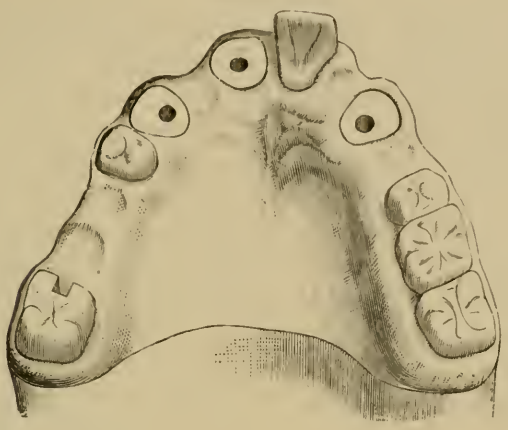
The false crowns, more frequently called dummies, are so made as to present only an edge toward the gum while having a full grinding surface presenting to the opposing tooth.

The common way of making them is to select a suitable porcelain face, grind the neck thin so that only an edge will come in contact with the gum, and grind the cutting edge square, a little shorter than the occlusion requires. Take a

* *Cosmos*, XXVII, 712.

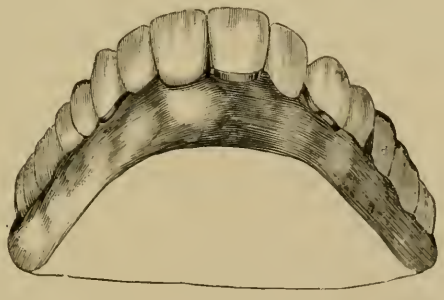
piece of pure gold, struck to the form of the grinding surface of a corresponding tooth by a die previously prepared, or formed to the occluding surface of the opposing tooth, melt

FIG. 272.



coin gold into the concave surface of this, file or grind this surface smooth, and fit it to the porcelain face already prepared and backed with pure gold.

FIG. 273.



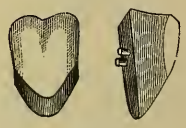
When fitted and secured in position with wax cement, place upon each side of the crown a triangular piece of pure gold or platinum closely adjusted to the sides of the porcelain, and

secure them in position. Invest this, wash out the wax, and this will expose a triangular box into which should be flowed coin gold or No. 1 solder. Fig. 274 shows different views of these crowns completed.

An excellent molar or bicuspid crown for bridge work may be made by using a common rubber tooth, grinding off the shoulder a little, and cutting off the heads of the pins and wrapping it with pure gold No. 30 or 31, as in Fig. 275. To do this, take some thick pattern tin and punch holes for the pins and fold it around the tooth, overlapping a little at some point. Cut out the grinding and buccal surface of the crown, leaving a band at the cervical portion, remove the tin and spread it out. It will be a correct pattern, by which to cut the pure gold, which will be found to fit correctly, when the

FIG. 274.

FIG. 275.



tooth may be invested and soldered with 18 k. plate. Be sure the gold is burnished down to contact with all parts of the tooth. Special care should be taken in heating and cooling when soldering these crowns, to avoid fracture of the porcelain.

If great strength is required, the neck of the tooth may be shortened and additional thickness of gold added. Crowns thus prepared and placed in position, and a bar of gold added to the lingual surface to strengthen them, and all well soldered, make work of superior excellence. It avoids the unsightly and glaring gold crown, and affords a porcelain biting surface, which is very much more agreeable and serviceable to bite upon. The English tube teeth can generally be used for the same object, by first making the bridge frame and soldering a

pin in position and slipping on one of these teeth ground to a proper length, and secured by gutta-percha or cement.

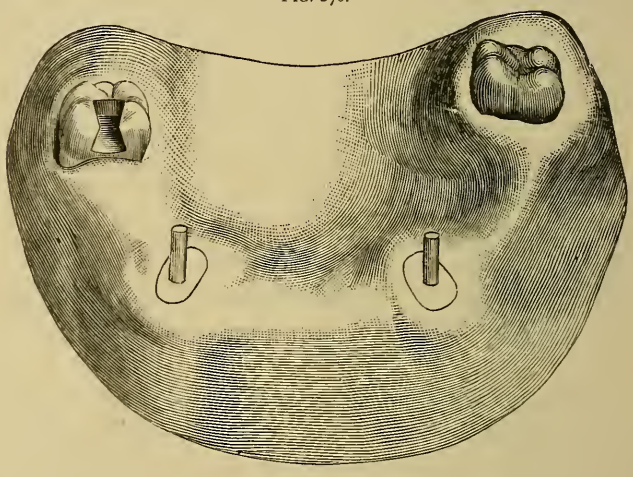
When all parts are made to fit their places, one or two false crowns may be attached by wax cement to the adjoining abutment, placed in the mouth and accurately adjusted to position and occlusion, and then removed, invested and soldered. This may be done on each end, so the bridge will consist of only two parts. When this is done, place the two parts in position, have the patient close the teeth and hold the parts to a correct occlusion. Mix some investment to set quickly, draw away the lips and cheek and cover the outer surface of the bridge with the investment. When firmly set, remove it. This will be a matrix, into which the pieces of the bridge may be placed in correct relation to each other. Secure by a little wax at a few points, to insure against moving. Place around this more investment, then gold plate may be added as is needed to strengthen the bridge, and the case soldered and finished, and adjusted.

The method of making the artificial crowns for the bridge is given in the following description of a case taken from Dr. Litch's excellent article in the "American System of Dentistry."

"The anchorage being now fully prepared, the cuspid and molar caps are placed in position, and with plaster an impression of the mouth is taken. If the caps do not come away with the impression, they are withdrawn from the mouth and placed in their proper position in the impression, which is then varnished or oiled, or both, and a cast run after the usual manner. After removal of the impression the caps will be found implanted in their proper positions upon the cast, as seen in Fig. 276. To facilitate the subsequent removal of the cuspid caps, the inner and the outer surfaces of the ferrule portions and the sides of the retaining-pins should be coated with a thin film of paraffine and wax, which by the application of a little heat will readily soften and permit the withdrawal from the cast. After the wax film has been removed,

the caps can be replaced in and withdrawn from their places on the cast at pleasure. A similar method should be adopted with the molar caps. Enough wax should be placed upon its inner surface to fill out the curvatures and make its walls parallel with the long axis of the tooth. Covering with wax the under surface of the crown-plate should, however, be avoided, as it is desirable to have that rest firmly upon the column of plaster which will be found as a part of the cast after the wax has been softened and the cap withdrawn.

Fig. 276.



"Upon the cast thus prepared a rim of wax attached to a paraffine and wax base-plate is modeled preparatory to taking the articulation. The details of this method do not at all differ from the methods described elsewhere in this work.

"The base-plate and wax rim are made to rest upon the cuspid caps, both when they are on the cast and when in the mouth, to which they are restored when the bite is taken.

"At the point where the wax rim rests upon the cuspid caps, it should not extend beyond their labial edge. The articulation and an impression and cast of the lower antago-

nizing teeth being secured, the cast is properly mounted upon an articulating frame.

"Suitable porcelain teeth are now to be selected and mounted. For the incisors and cuspids plain plate teeth are usually selected; they should be strong and well made. The molars and bicuspids are built up almost entirely in solid gold, and are sometimes made throughout of that metal; but usually porcelain facings are employed, which at least serve to protect the gold from view, its conspicuousness being objectionable.

"For bicuspid facings cuspid teeth strongly made and with heavy pins may be used. In fitting, only the outer edge of the necks of the teeth should be allowed to rest upon the gum. The teeth should be so spaced that the cuspids will come into proper position upon the caps prepared for them. In fitting them to the caps the utmost nicety should be observed, so that there may be no space left between the tooth and the cap.

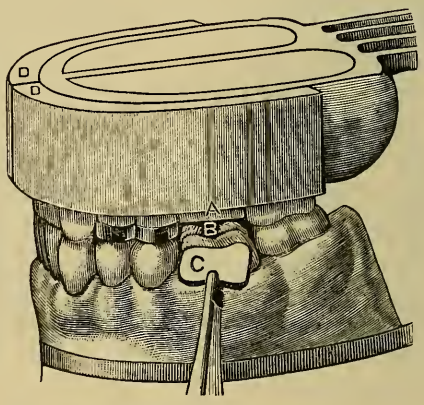
"If the front of the cap is above the level of the gum, and thus exposed to view, it can often be concealed by bringing the neck of the porcelain tooth over it, using very small corundum wheels to grind out on the under surface of the porcelain a concave space adapted to the convexity of the cap; by this means the cap can often be perfectly concealed from view by a film of porcelain which, although thin, will in that position rarely be fractured.

"The teeth being fitted into position on the model, a matrix in two sections is run over their outer surface, and upon the outer face of the cast, on which, as guides, conical depressions are previously cut. The matrix is seen as D in Fig. 277. The teeth can be taken from it and returned to it at pleasure—a great convenience in subsequent processes.

"As molar and bicuspid facings are subjected to great strain when mounted upon a rigid and unyielding piece of bridge work, it is generally desirable to shield them from pressure by a heavy gold crown plate; this can be made in precisely the same manner as previously directed for making the crown

plate for the molar caps. As the shell of the crown plate follows the dimensions of a natural tooth, and molar facings are usually much narrower, it is necessary to make the shell and facing correspond in width; this is readily accomplished by bending in the edges of the shell to the necessary extent with a pair of pliers. The palato-buccal diameter of the shell should also be reduced, as it is rarely desirable to make artificial molar teeth of any kind the full size of the natural organs. The shell, being thus prepared, is filled with 18-carat gold and a box plate attached precisely as previously described for the crown plate of the molar tooth.

Fig. 277.



"The porcelain molar-facing upon which it is to rest is then ground away sufficiently to allow the crown plate to slip in between it and the occluding teeth, as seen in Fig. 280.

"Letter A is the porcelain face cut down at B to admit crown plate C, which is being passed into position between the porcelain face and the occluding tooth; it is the plaster matrix which holds the teeth in position upon the cast when the articulating frame is reversed. As represented in the cut they would drop out.

"Too much care cannot be exercised in making the joint

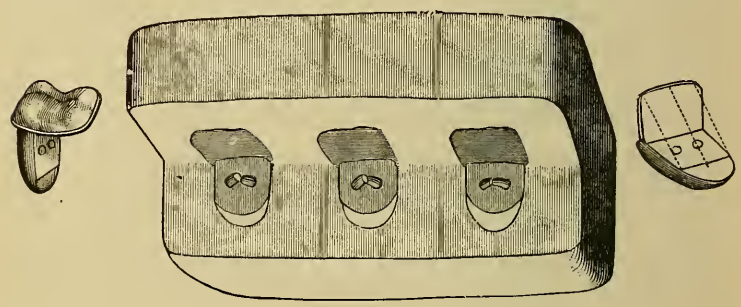
between the porcelain facing and the crown plate a perfect one. For artistic effect, and also for cleanliness, there should be absolutely no space at any point. To secure this result, it is well, after all but the finest irregularities have been removed by the corundum wheel, to place a little wet pulverized corundum between the two surfaces and rub them together. This, if skillfully done, will make an almost impermeable joint. In fitting to position allow the crown plate to project a very little beyond the buccal surface of the porcelain facing. This projection is to be cut away in finishing, and gives a little margin for perfecting that process.

"After the same manner crown plates are prepared for the other molars and bicuspids, which teeth are then removed from their matrices and backed with platinum No. 27 standard gauge. Each backing is made to extend from the grinding surface, when it is brought in close contact with the crown plate, to the extreme edge of the neck, and to cover the entire inner surface of the tooth from side to side. It must be adapted to the porcelain surface with the utmost nicety. The platinum being pliable, can be bent and burnished into the closest contact; so that the joint shall be impermeable. The proximal and cervical margins are bevelled down to a feather edge; the coronal margin is left square. (The facing as thus prepared, with its crown plate and backing, is seen in Fig. 278.) Cement is then placed between the crown plate and backing and the tooth invested in the marble-dust and plaster mixture already recommended, preparatory to soldering the platinum pins of the porcelain facing to the backing and the backing to the crown plate, at the same time filling in solidly, with metal, the angle between the latter two. It is an economy of time and labor to place three or four teeth in the same investment, taking care that sufficient space is left between them to prevent union. Invested in this manner the teeth will present the appearance presented in Fig 279. The dotted lines seen in Fig. 280 indicate the surface to which the gold is extended in the soldering process.

"In soldering great care must be taken to secure a uniform temperature throughout the investment and its enclosed teeth; such large masses of metal are to be imposed upon the porcelain facings that unless the utmost caution is observed there is great danger of fracture. The safest plan is to heat the investment to a dull-red heat over a gas-stove or other suitable heating apparatus, and then transfer it to a hot bed of charcoal in the soldering furnace; by this means the heat can be raised gradually and uniformly and be maintained at the required point throughout the soldering process.

"If the blowpipe flame alone is depended upon, there is always the danger that the face of the porcelain teeth next to

FIG. 278. FIG. 279. FIG. 280.



the metallic backing will be heated to a much higher point than that in contact with the investment, unequal expansion, followed by fracture, being pretty sure to result. With single teeth fracture in soldering does not usually depend upon too rapid heating or too rapid cooling, but rather upon unequal heating and cooling. A good porcelain single tooth protected from direct contact with flame by a suitable investment can be safely raised to a full red heat in five minutes, and cooled to the temperature of the air in as many more, provided that care be taken to make the application of heat uniform and progressive. If a pointed blowpipe flame at perhaps the temperature of 2000° F. is thrown upon that face of the porcelain

covered by the backing, while the other, covered by a thick investment, remains at a temperature not much, if at all, above 212° F., as indicated by the still-escaping steam from the plaster, fracture is sure to result. The thicker the investment the more difficult does it become to equalize the temperature on both sides of the porcelain tooth. For this reason it is rarely desirable to make the investment more than half an inch in thickness.

"The description just given of the methods of making molar and bicuspid bridge-teeth must be slightly modified for the left molar bridge-tooth, to which the bar already shown (Fig. 270) is to be attached.

"To this molar the mesial end of the bar is cemented, the

Fig. 281.

Fig. 282.

bar being placed against the backing and beneath the crown-plate, as seen in Fig. 281.

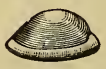
"The angle between the backing and crown-plate being filled with wax-and-rosin cement, the bar will be strongly held, and while the cement is still plastic the tooth and bar are conveyed to position in the mouth and the adjustment of the bar to the slot, and, at the same time, of the crown-plate to occlusion, is preferable. The cement is then chilled and the tooth invested and soldered as before described. The investment grasps the distal end of the bar and holds it in position after the cement has melted, while the gold solder takes the place of the cement and holds the bar firmly and rigidly in place.

"Fig. 282 gives a sectional view of the completed typical bridge-tooth, porcelain seen in Fig. 281 having been filed

away to a level with the buccal surface of the facing. The relation to the alveolar ridge of the cervical edge of the bridge-tooth when in position is shown in the diagram. All exposed surfaces, except the coronal, form inclined planes, upon which it is impossible for food to lodge or remain.

"As the contracted cervical edge barely, if at all, touches the gum, it affords no obstacle to the flushing effect of water held in the mouth and washed to and fro under the denture. All the broader surfaces are readily accessible to a properly-constructed brush. The molar and bicuspid bridge-teeth being completed, the cuspids and incisors also, are to be backed and soldered. Platinum backings should be used for each, and the solder should be 18-carat gold plate. In soldering the cuspids the palatine surface should be filled out to contour, as

FIG. 283. FIG. 284. FIG. 285.



seen in Fig. 283. The two cuspids may be soldered in one investment, and the four incisors in another. Upon the backing of each incisor a large excess of gold should be flowed, as seen in Fig. 284, where it is made about the twelfth of an inch in thickness. If it is found desirable to have a shoulder upon the inner edge of the incisor for occlusion with the lower teeth, this can readily be secured by cementing a strip of 22-carat gold at the proper point transversely across the backing, as seen in Fig. 285, and flowing in gold up to the dotted lines. The several pieces of the bridge being now completed, all that remains is first to unite them into sections, and then join the sections, thus constituting a continuous arch. The first section will be composed of the right cuspid and molar abutment-teeth and the three intermediate bridge-teeth. The

second section will be formed of the left cuspid, the left molar, with the anchorage-bar attached and the intervening bicuspids. The third section will consist of the four incisors only.

"To build the sections, the teeth composing them are restored to their several positions in the matrix upon the cast, the sides of the crown-plates and metallic backings, if redundant, being cut down sufficiently to allow the teeth to rest side by side in the matrices. It is desirable that the edges of the crown-plate should be fully in contact, but that the backings should touch only toward the buccal surfaces of the several teeth, from those points to the palatine edges of the backing narrow V-shaped spaces should be left, into which the solder will readily flow and thus ensure the effectual filling up of the joint, and consequently the firm and strong union of the several teeth and caps which compose the section. After being satisfactorily arranged in the matrix, the teeth and caps are strongly cemented together with a brittle wax-and-resin cement, and transferred to position in the mouth when the final adjustments are perfected.

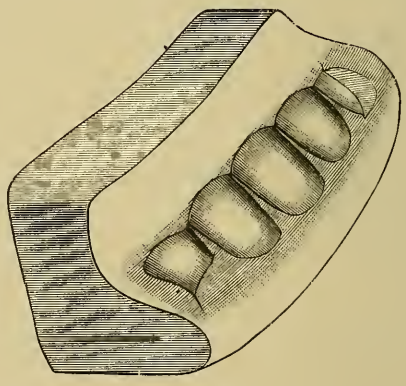
"The cement is then chilled. In this state it should be quite strong enough to hold together the several parts of the section. But, usually, such cements are not strong enough to withstand the strain necessarily put upon them in withdrawing tightly-fitting caps from anchorage-teeth. In such cases a thin matrix should be moulded over their buccal surfaces as, held together by the cement, they stand in position in the mouth. This matrix should be made of a quickly-setting plaster mixed to a thick batter. It is to be spread by a spatula over the entire front of the section, that surface of each tooth and cap composing it being fully covered, the plaster at the same time being run well into the interspaces. After the plaster has hardened, the matrix is removed from the mouth, as also are the teeth and caps. These, on being replaced in the section matrix, are there held in precisely the same relative position which they occupied in the mouth.

"Bridge-teeth and anchorage-caps are then very strongly cemented together and the cement thoroughly chilled, to avoid the possibility of bending. The section is then carefully lifted from the matrix, invested, grinding surfaces down, in the marble-dust-and-plaster investment, and soldered with the zinc alloyed 18-carat solder previously recommended.

"Fig. 286 shows the right section thus invested. The same methods are to be employed in forming the other sections.

"Finally, the three sections must be joined, to form the continuous arch. The point of junction will be between the cus-

Fig. 286.

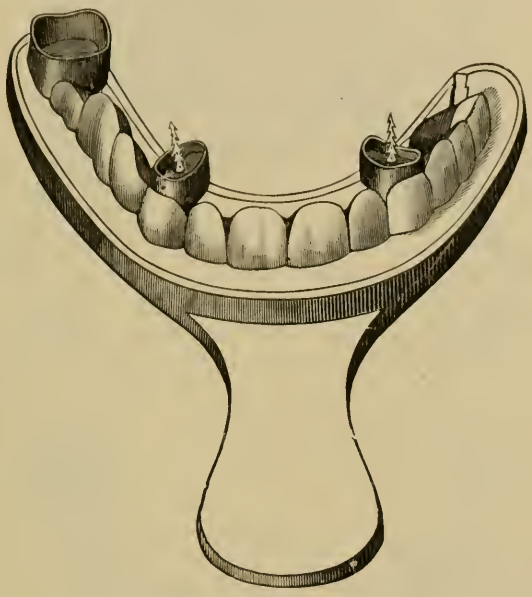


pids and laterals of either side. These two points must first be strongly cemented. This is best accomplished by thoroughly drying the right and left sections, and then placing them in position in the mouth, where, by means of napkins, they must be carefully protected from moisture. The incisor section is then also dried and slightly heated. The distal surfaces of the lateral incisors is covered with quite a thick layer of the wax-and-resin cement, and while this is still soft and adhesive, the section is carried to the mouth and pressed into place, where the cement serves to attach it to the other section. If the adhesion is not satisfactory, it can be improved

by remelting the cement with a hot iron, at the same time the surfaces to be joined. The cement should then be chilled.

"A matrix is then made somewhat after the manner of taking an impression, the plaster being allowed to cover the teeth, previously slightly oiled, for about one-third their length above the cutting-edges and grinding-surfaces, as seen in Fig. 287. The impression-tray is shallow and need contain only a small amount of plaster.

FIG. 287.

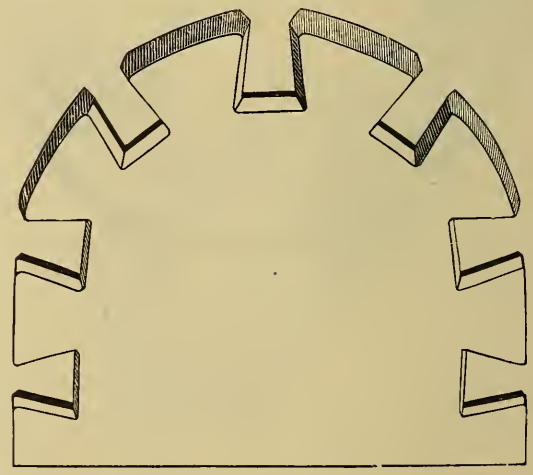


"The matrix must be trimmed away until the bridge-piece can easily be detached and be replaced or withdrawn with perfect freedom. If the cement between the cuspids and laterals has been fractured, it must be again restored and hardened. The case is then, with the most scrupulous care and delicacy of manipulation, lifted from its place in the matrix and transferred, crown side up, to the investment-slab seen in Fig. 288, which is designed to give a rigid and fixed

support to the bridge-piece and its investment, and thus prevent warpage of the one or fracture of the other during the soldering process.

"The investment-slab is made of fireclay, about one-fifth of an inch in thickness, its other dimensions corresponding to those of the case to be invested. On its outer circumference are placed dovetailed notches, made larger on the under than the upper surface of the slab. These serve as anchorage for the investment and prevent its breaking away from the case or

Fig. 288.

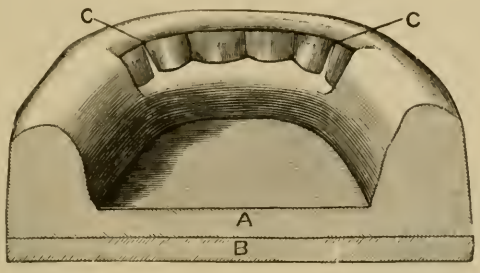


from the slab. In investing, those notches are filled with the investment mixture (beach-sand and plaster-of-Paris, equal parts), and at the same time a sufficient amount of the material is heaped up upon the slab (previously placed upon a flat, smooth surface) securely to imbed the bridge-piece as it is transferred from the matrix.

"All parts of the case, except immediately around the surfaces to be soldered, are covered with the investment, which, as already stated, need at no point be more than half an inch in thickness.

"Fig. 289 shows the invested case. A is the investment; B, the investment-slab; C, C, the joints to be closed. It need hardly be stated that in this final soldering the same care in regulating the temperature should be observed as has been

Fig. 289.



previously directed. In this soldering the zinc-alloyed gold solder should be used and the joint between the laterals and cuspids on either side should be fully filled. After cooling, the case is then ready for the final finishing processes and for adjustment in the mouth.

Fig. 290.

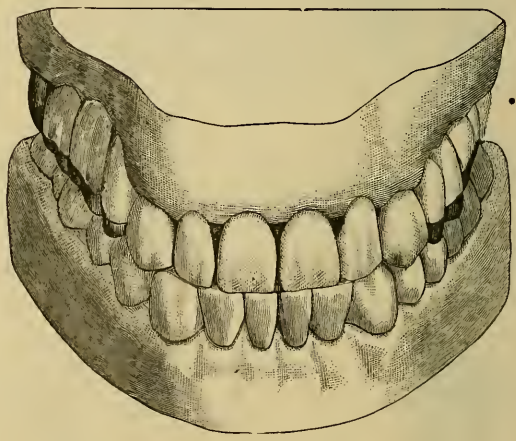
"Fig. 290 shows the completed case detached and in Fig. 291 it is seen in position.

"If the directions given for the construction of the cases of bridge-work have been carefully followed, the denture, after

the final soldering and finishing, should pass up into position in the mouth and fit with perfect accuracy.

"Any warpage indicates defective manipulation. This fault is readily detected by testing the case in the final matrix (Fig. 287), in which it should fit as perfectly after as before investment and soldering, except that a little excess of solder in the joints between the incisors and cuspids may cause a maladjustment at those points—a fault, however, easily discovered and remedied, either by removal of the solder or by scraping

Fig. 291.



away the plaster of the matrix; which being done the case will go fully into place.

"In placing the completed arch upon the anchorage-teeth some difficulty may arise in consequence of a want of coincidence in their respective angles of inclination. This is a detail which must be looked to before determining the plan of the bridge, and the case should, as far as possible, be constructed with a view to avoiding the complication, such anchorages being selected as will accomplish this end, and at the same time be satisfactory in other respects.

"With every care, however, it may sometimes happen that while the individual sections are readily adjustable to their respective anchorages, they, when united, interlock in such a way that either removal or replacement is difficult or impracticable. This is a point which by the aid of the final matrix can and should be fully tested before the sections are united by solder; for the plaster of the matrix holds them firmly together, and if while thus held in contact they cannot be withdrawn from their respective anchorages, or, being separately withdrawn and restored to their relative positions in the matrix, they cannot be replaced upon the anchorage-teeth, it is entirely inadvisable to proceed farther until the difficulty is remedied.

"Usually, this can readily be accomplished by cutting away that face or angle of the anchorage-tooth or root which is the point of difficulty. Sometimes the simple shortening of the retaining-pins, or the enlargement in a given direction of one or more of the pulp-canals, will overcome the trouble. To precisely locate the points of interference, the surface of the implicated teeth or roots may be covered with a thin film of wax, or the edge and inner surface of the ferrules may be covered with a layer of rouge or plumbago, which will leave a distinct mark upon the anchorage-teeth at whatever points pressure is most considerable, which points being then cut away, the denture may readily pass into place. All remedial measures of this kind failing, some modification of the plan of construction of the denture, of a nature to simplify its anchorages, will be necessary."*

Low Bridge.—"For the first illustration, as seen in Fig. 292, we have a case where all the teeth have been extracted except the two cuspids and two second molar roots.

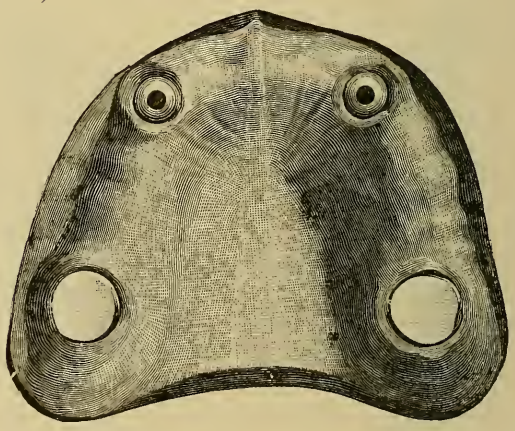
"We first proceed to prepare the roots by crowning. I use gold crowns on the molar teeth and the Low crown on the two cuspids.

* "Am. Syst. Dent.," II, 846.

"The preparation of the two cuspids consists in making the crown ready for adjustment. I always measure the tooth to be crowned with gold with a strip of block tin, about 35 Stub's gauge. Place the tin around the tooth, and with pliers carefully measure the full size of the same.

"Should you be measuring a tooth or part of a tooth on which there are projections; take the engine and with a stone grind off the same, making a smooth surface, so there will be nothing to interfere with the proper fitting of the bands. After cutting the tin measures by the marks made by the pliers, you

FIG. 292.



have the measures ready to make the gold bands by. Cut the bands and bevel the edges and solder together, and you are ready to fit. After fitting all the bands and finishing the crowns in the usual way, I place each in position in the mouth, having previously regulated the articulation of each crown as desired in the process of making. I now take a deep articulation in wax and impression in plaster of Paris; remove before it gets too hard, and place all the crowns in their positions in the impression; varnish, oil, and pour in the usual way; separate the cast from the impression and place in the ar-

ticulator. Then pour plaster. After the plaster has hardened, remove the wax, and we have the articulation proper and are ready to select and grind our teeth, having previously selected our shade. My experience has long ago taught me that no porcelain teeth can stand the pressure for bridge work, the strain on them being twice as great as with teeth on plates, which rest on the gums, that give to pressure. In order to prevent breakage of teeth and give strength, I have for many years been making a tooth with gold cusps. I will here describe my manner of doing so.

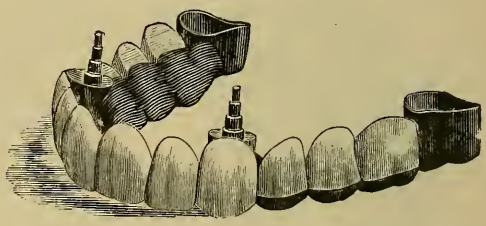
"I had some shells of bicuspids and molars made, or rather teeth, without the crown. They can now be found in some of the dépôts. For the first step I use 28-gauge platinum for a covering of the inside of the shell, or just where you wish gold to flow. Then I bend the pins down to hold the platinum in position, and with a file remove all overlapping platinum to prevent breaking of our teeth in heating. The tooth is made flat on the crown surface with the express intention of restoring with a gold crown. The crown need not be very thick, but should perfectly resemble the cusps on the natural tooth for the purpose of mastication. As these cusps are not on the market, and every dentist making bridge work cannot make it in a way to stand without putting gold cusps on the grinding surface of the bicuspids and molars, I will here describe, for the benefit of those who do not know how to make them, how they can be made with very little trouble. Pick out a natural tooth with cusps the exact shape you wish to have your gold cusp; mix some fireclay in a thick paste, then press your tooth into it a little deeper than you wish the cusps. Having made the proper impression, remove the tooth, and set the impression over the gas stove to dry. After it is dried and reasonably hot, lay your pieces of gold in the impression and with a blowpipe melt them. When melted, press with a piece of steel on the gold till cool. This mould will do to make many from. If you have not the fireclay, and can get charcoal that is burned from fine-grained wood, and is

soft, you can simply press your tooth into the charcoal and melt in the same way, or you can carve your teeth as you desire in a block of carbon. Of course, the little steel dies are handier, as we can swage up our gold cusps in them, either solid or thin.

"Having described our manner of making the cusps, we will now return to the manner of finishing our tooth. I left off by saying we covered the inside and bent down the pins and filed off the overlapping platinum. We now place the cusp on the top of the tooth, and place in the position desired, holding it there with wax, and with a spatula trim the wax the exact shape we wish our tooth to be—V shape, tapering from the crown down. We now encase in plaster and sand, which gives

FIG. 293.

FIG. 294.



us a box. When hard remove the wax and place over the stove, and when sufficiently dry, fill in with coin gold, using the blowpipe to melt it in a solid mass, and then our tooth is ready to fill up and place in position on the articulator. Fig. 293 shows the tooth in this condition.

"After our teeth are all arranged we hold the same in position with wax, remove from the articulator, encase with plaster and sand or asbestos in the usual way. That we may have a strong case, I always use platinum wire between all the teeth, and then proceed to heat and solder. Be sure all the gold cusps are so arranged that you can get all soldered together, as this gives us great strength. My formula for solder, which I have used for many years, and which will be found very easy

flowing and almost the exact color of the gold you are using, is as follows (always figure from the carat of gold you are working): Take one pennyweight of coin gold, two grains of copper, and four of silver. We now have our case soldered; after filling as desired, commence to finish with felt wheels and pumice-stone, after which use rough buff wheels. We are now ready to adjust in the mouth. In Fig. 294 we see the case ready for adjustment.

"Have the assistant dry all the teeth or roots to be operated upon while you are mixing the cement. Be sure and use a kind which does not harden very rapidly, or your cement will set before you get your teeth adjusted. Use sufficient cement

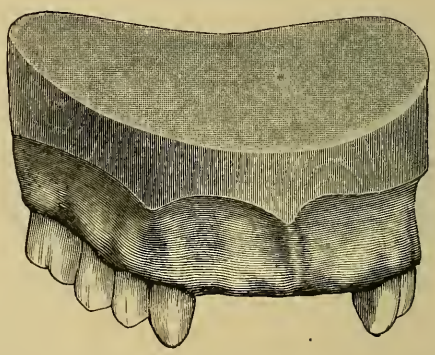
FIG. 295.

to fill all the gold crowns perfectly when the case is driven to place. Moisten the step plugs and cap with cement, touching every portion, and with an instrument place a little cement in the bottom of the cavity. We now adjust our case, using the little rotor for the Low crowns and a piece of ivory for driving on the gold crowns. Fig. 295 represents the case when in position.

"It will be seen by looking at Fig. 294 that the teeth after having been soldered are all spaced fully one-third of the distance from the place of contact with the gums and the grinding surface of the teeth, so that the secretions could not possibly lodge there. I have given you a description of my manner of

making a full upper case of bridge work where there are roots to be crowned to support the bridge. I will now describe my manner of operating upon a case where the four centrals are missing, as seen in Fig. 296. To supply these four teeth where the cuspids are intact, I use a gold band. I first measure the tooth with strips of tin, and make the gold bands, as before described, and cut out the outside lower portion of the band before beginning to fit. In fitting, as the band is being driven down, cut away any of the band that touches the gum before all touches; never drive the band under the gum, as inflammation would probably follow.

Fig. 296.



"I mention this as I have seen many attempts to get rid of the bands by driving up under the gums and cutting them out on the front, until they were too narrow for strength. It is hard work to make something out of nothing. The bands should be heavy and strong, and the patient made to understand that if he expects to get rid of the annoyance of the plate he must sacrifice his dislike to showing gold. After driving the bands up close to the margin of the gums, as the cuspid teeth are very tapering, the bands will have to be taken in at the bottom. To do this, I slit the band about a third of its length up, then place it on the tooth again, lap it

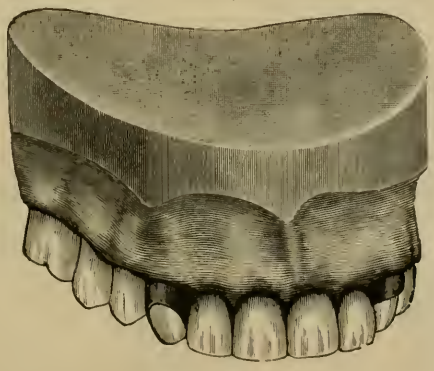
over enough to bring it to a close fit, and then take it off and solder.

"Continue taking it in wherever it does not perfectly fit the tooth, and after a good fit is obtained, proceed as before described, by taking an articulation and impression. In adjusting, first try the case on to see that it fits, and that the articulation is all right. Fig. 297 shows the case ready for adjustment.

"Next have the assistant dry the teeth upon which the bands are going, and then mix your cement. This should be mixed to about the consistency of thick cream. It must be neither too thick nor too thin, or the adhesion will not be strong enough to hold. Cover your teeth with cement, and then the inside of the bands. Place these on the teeth and carefully mallet up into position. For this purpose I use a steel instrument with a crease or groove in the end. The teeth must be kept dry after the case is in position until the cement is well set. After this is done,

Fig. 297.

Fig. 298.



bevel the edges of the bands and burnish close to the teeth, and if properly done they will be made to resemble gold fillings. In Fig. 298, we have the case completed.

"I am aware that in a case like this, porcelain crowns instead of gold bands could be used, and I should consider it much preferable to do so where we have roots or unsound teeth to operate upon; but I do not advise the destroying of nerves, where the teeth are intact, to supply such a case with crowns, as the bands will answer every purpose for many years.

"If they should give out in after years, the roots can then be crowned. I have many of these cases that have been in use seven and eight years, some of which have never loosened, and some I have reset nearly every year. I always impress upon the patient the necessity of having them reset immediately should they become loose, and advise them to have their cases examined at least once a year. Should parties insist upon having crowns used to supply a case like the one just described, on perfectly sound teeth, I should begin by using an aluminum disk with corundum, cutting deep as possible both on the labial and lingual sides, and then use the excising forceps. This can be done under the influence of an anæsthetic or otherwise. It is not by any means so painful an operation as one would think. If the nerve does not come out with the piece of tooth cut off, I take a piece of orange-wood, which I have previously cut the proper shape, to drive into the nerve canal. I place it in creasote and let it soak a few minutes before beginning to operate. Immediately after severing the tooth drive this into the canal, then remove and dip in creasote, and drive in again. This will perfectly fill the nerve-canal; all sensitiveness will disappear, and you can begin to operate at once. I do not recommend this treatment for sound teeth, but I have treated many exposed nerves in this way, also many teeth broken by accident, and think this the most satisfactory way to dispose of such cases. I have never had any unfavorable results follow after operating upon teeth in this way, and I can hardly say as much in favor of any other treatment. I speak of this manner of treating exposed nerves as one of the operations that sometimes become necessary in

adjusting a bridge properly. I do not claim any originality in this mode of treatment. I know several dentists who use this method, all of whom report satisfactory results. We now have Fig. 299, showing the roots prepared to receive the case.

Fig. 299.

"I have many of these cases in use that are giving entire satisfaction. The instrument selected for preparing these roots should be one with small inside cutters and large bevelers, so as not to cut away any more tooth substance than possible.

Fig. 300.

Fig 301.

"Fig. 300 represents the case ready for adjustment. Fig. 301 represents the case after adjustment.

"In this article I have described my manner of making teeth for bridge work. I am now having made a tooth expressly for bridge work, which I hope to be able to place on the market soon. I have been using these teeth, but have not perfected my shells and moulds sufficiently to enable me to get them out in large quantities.

"Fig. 302 shows us a socket. This I propose to have ready made in various sizes in bicuspids and molars, with corresponding shells. Figs. 303 and 304 represent the shells placed in sockets. Fig. 303 is a molar tooth showing the shell in position, and Fig. 304 is a central reversed. Fig. 305 represents the socket as made for the four central and two cuspid teeth. The advantage of these teeth can readily be seen, not only for bridge work, but all gold plates. A tooth, if broken, can readily be replaced without removing the bridge or crack-

FIG. 302. FIG. 303. FIG. 304. FIG. 305. FIG. 306.

ing by soldering, and with only a small expense. Fig. 306 represents the shell placed in position in the socket, which can be used for bridge or crown work, and will greatly reduce the labor in making either."*

Parmly Brown Bridge.—"This system has the metal baked invisibly through the body of the teeth. No metal shows either inside or outside of the dental arch. The six anterior teeth are riveted to the platino-iridium bar by the ordinary pins of plate teeth, which are the teeth used for this work. The bicuspids and molars are prepared by grinding a slot on the palatal surfaces of the teeth. The bar (which is squared for these teeth, instead of being flattened as for the front teeth) is inserted into this groove or slot, which should be ground with

* "Am. Syst. Dent.," II, 908.

a thin corundum wheel to fit the bar, which can be barbed to make proper impingement. It is then ready to receive the creamy tooth body, which, at this juncture, is applied to the palatal surfaces of all the teeth, completely covering the metal and giving the natural contour to the inner surfaces. A little of the tooth body is allowed to run between the teeth, uniting their approximal surfaces. In this work, when cross-pin teeth are used, the pins will be ground out in most cases; but if straight-pin teeth are used, the pins will be bent over the bar. I will give a few illustrations of the many ways in which this work can be done.

"Fig. 307 is a view of a platino-iridium bar baked on to a plain-plate tooth, by first riveting the flattened bar on the pins,

Fig. 307.

Fig. 308.

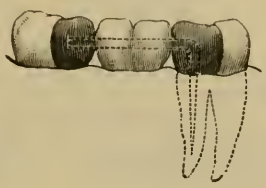
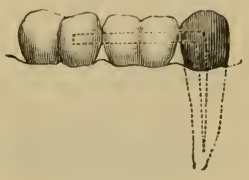


Fig. 309.



then applying tooth body to the back, completely covering bar and pins, and then baking in a continuous-gum furnace. The body can be applied readily of a creamy consistence, and, after being held a moment over a spirit-lamp, is ready to be put on the slide and baked.

"Cavities or fillings are usually found on either side of a space made by the loss of a tooth or teeth that will allow the insertion of the ends of the metal bar and the thorough impacting of gold around them. Amalgam can be used in posterior teeth in many cases, or gold crowns penetrated by the bar, as in Figs. 308 and 309.

"In Fig. 308, No. 1 is a third molar, pulp alive, with large filling; No. 2 is a porcelain bridge; No. 3 is a first molar, pulp dead, with a metal bar entering the pulp cavity.

"In Fig. 309, No. 1 is a second molar, pulp alive, with a crown filling of gold or amalgam retaining the bar; No. 2 is a porcelain bridge; No. 3 is a gold crown with bar passing through crown into root.

"Fig. 310 is a view of a bridge of two teeth—a central porcelain crown with a lateral baked into it, the bar and pin being of the same piece, bent at right angles.

"In Fig. 313, No. 1 is a porcelain crown forming part of the bridge; No. 2 is a bridged lateral with metal bar baked through it; No. 3 a living cuspid with a metal bar running in the centre of a solid gold filling.

"Fig. 311 is a view of a central incisor bridged on to two teeth whose pulps have been lost.

Fig. 310.

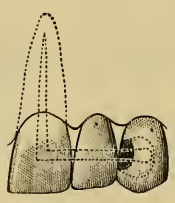


Fig. 311.

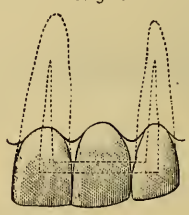
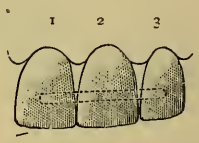


Fig. 312.



"As many as six teeth have been inserted in this way on two central roots, and the posterior end of the invisible metal bar running through the six teeth worked firmly into a gold filling in a molar—the six teeth being united on their approximal surfaces by the porcelain running between them at the baking. The backs of such teeth must be given a curved form to insure a cleanly condition.

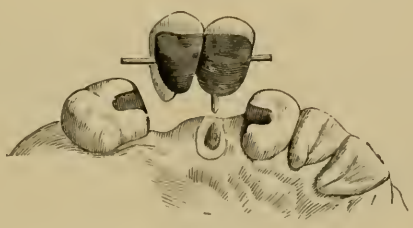
"Fig. 312 is a view of the attachment of the bridge to a tooth standing alone, where the tooth has a gold crown attached, or the bar is worked into a filling. Nos. 1 and 3 are teeth on a porcelain bridge; No. 2, the natural tooth over which the bridge is saddled.

"All teeth for this bridge work should be ground so that no

considerable portion of gum would be covered, the teeth just touching the gum by a point only at the cervico-labial portion."*

Cryer's Bridge.—"In the mouth of a student at the Philadelphia Dental College, where the first right superior bicuspid was missing, and there remained a portion of the root of the second bicuspid not strong enough to sustain a crown, and likewise irregular as to position in the arch (see Fig. 313), the following operation was performed: There was a cavity on the disto-palatine surface of the cuspid and a mesial and crown cavity in the first molar. The above mentioned root was treated and prepared as for filling. An impression of the parts was taken and casts made showing the articulation with the

FIG. 313.

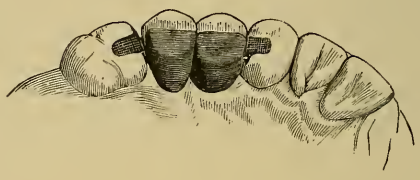


lower teeth. A piece of slightly flattened platinum wire was fitted into the root for a dowel. A small portion of the cast was trimmed off, so as to cause the neck of the artificial crown to bed into the gum. A piece of thin platinum was burnished over the root and the vacant space corresponding to the original position of the first and second bicuspids, and a hole made through the platinum to accommodate the pin which was to be inserted into the root. The pin was now passed through the plate into the root, and treated as previously described in crowning with a plate tooth. Two cuspids were selected, shaped, and backed with platinum; a piece of No. 18 platinum

* *Cosmos*, XXVIII, 583.

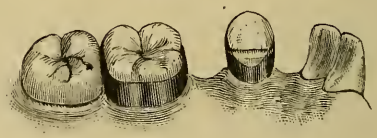
wire, reaching from the cavity in the cuspid to the cavity in the molar, and passing close to and back of the artificial crowns, was attached to the teeth and plate with wax. After trial in the mouth, the appliance was invested and soldered with pure gold over the pins, stays, and transverse wire (see Fig. 313). In such a case, before inserting the ends of the horizontal wire into the natural teeth, it is best to fill the cervi-

Fig. 314.



cal portions of the cavities with gold, after which adjust the dowel in the gutta-percha in the root, as before described, and complete the operation by finishing the fillings in the natural crowns (see Fig. 314). The fillings can be temporarily made of oxychloride of zinc or gutta-percha, especially if they are large, and the patient may be allowed to wear the porcelain teeth for a few days, when, if desirable, the oxychloride of

Fig. 315.



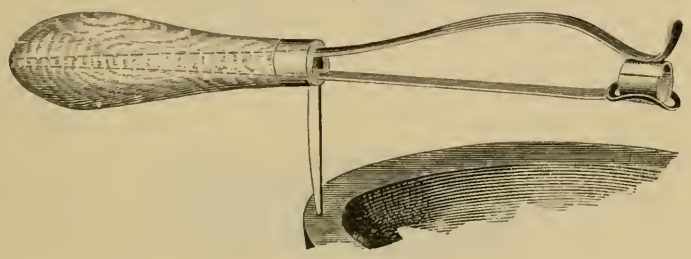
zinc or gutta-percha can be removed and the cavities permanently stopped with gold."*

Melotte's Bridge.—"Fig. 315 illustrates a case for the supply of a lateral and a bicuspid. In this instance the cuspid could be cut off, and the root collared and capped in combina-

* *Cosmos*, XXIV, 360.

tion with a pin entering the enlarged pulp canal; but, as there may be grounds for objection to cutting off sound teeth, I obviate the necessity by cutting a shoulder on the lingual portion of the cuspid, and suitably shaping its sides to permit a close fitting of the collar just under the free margin of the gum. A narrow strip of pure pattern tin, bent tight around the tooth neck, and cut through with a knife at the lap on the labial surface, will serve as a measure for the length of a strip of 22-carat gold plate, No. 29 thick, and as wide as the length of the distal side of the cuspid. The ends of the gold are then squared, and with round-nosed pliers brought evenly together, to be held in flush contact by the soldering clamp shown in Fig. 316. The soldered collar, with its joint side

FIG. 316.



inward, is then adjusted on the tooth as accurately as possible, giving slight blows with a mallet until the collar touches the gum, when it should be marked to indicate the necessary trimming to conform it to the gum contour. After it has been thus trimmed, the edges beveled, the labial part swelled with contouring pliers, and the lingual part cut down to about one-tenth of an inch in width, the collar is again driven on and will appear as seen in Fig. 315. A stump corundum wheel is then used to grind a shoulder on the lingual surface of the tooth, grinding also the edges of the collar flush with the shoulder. The collar is again removed, and a piece of thin platinum plate, about No. 32, sufficient to cover the lingual

surface of the tooth, is caught on the lingual edge of the collar by the least bit of solder, and all put in place on the cuspid (see Fig. 317). The platinum should now be burnished on to the shoulder, and over the tooth and collar to the extent shown by the lines in Fig. 317. After trimming to those lines, and careful replacement and burnishing on the tooth, the collar and half cap are removed, filled with wet plaster and sand, and the platinum soldered to the gold. It is then placed on the tooth, burnished into all the inequalities of the tooth, very carefully removed, invested, and enough solder flowed over

Fig. 317. Fig. 318. Fig. 319.

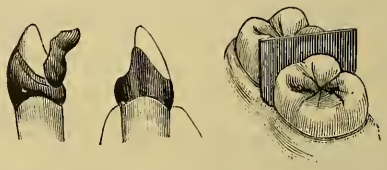
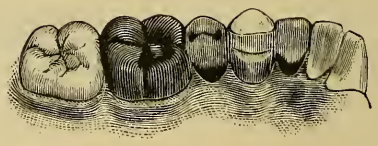


Fig. 320.



the platinum to cover and give it strength. Fig. 318 shows it complete on the cuspid.

"I have feared that a detailed statement would imply a long and tedious process, but I have often made such collars in less than an hour, and in any case time must be made subservient to exactness of fit and adaptation to the end in view.

"In the preparation for fitting a collar on the first molar (Fig. 315), I should have wedged or otherwise separated it from the second molar, so that a piece of sheet brass might be put in place, as shown by Fig. 319, and an impression taken in plaster, which, if allowed to get hard, would bring away the

metal. If not, it could be replaced in the plaster. Melted fusible metal, when near the cooling point, is then poured into the impression, and when cold will allow the safe removal of both the plaster and the metal strip. On this metal model a collar can be formed that will accurately fit the molar, as seen in Fig. 315. If the molar has no antagonist, a cap may at once be struck up on the model; but if there be an antagonist, the cusps of the natural molar should be removed by grinding at points where the occluding tooth will admit of sufficient thickness of the gold cap. An exact copy of the ground cusps can then be made in less than five minutes, by the use of Moldine with its accessories, and the process is as follows: Make the tooth perfectly dry. Put the collar on it. Nearly fill the cup with Moldine, and coat it with soapstone powder. Press the compound on the tooth and collar firmly to about one-fourth the depth of the tooth. Carefully remove the cup; trim off any overhanging material, and place the rubber ring over the cup to about one-half the depth of the ring. Melt the fusible metal and pour it as cool as it will run from the iron ladle. As soon as the metal is hard, remove it from the ring, taking care not to impair the impression, which can be used again if the die is found imperfect or gets injured in use. Place the die and ring in cold water, to remain until quite cooled. While the die is wet and held over a basin of water, pour into the ring fusible metal which has been stirred until it begins to granulate, and quickly immerse all in the water. The die and counter-die should separate readily by tapping them with a hammer, but if they stick, others can be quickly made from the same impression, by the same method, using more care. With this die and its counter-die, a piece of No. 29 or 30 gold plate is swaged to fit perfectly the cusps and collar, which, when removed, can be held to its place on the cap by the soldering clamp, using spring pressure enough merely to hold them together for careful soldering with the pointed flame so as not to unsolder the collar. The seamless collars are excellent when care is used in selecting the proper size, as

directed in the diagram. Such a bridge is shown completed and in position in Fig. 320."*

Richmond Removable Bridge.—" Dr. C. M. Richmond, in making removable dentures of the entirely soldered kind, employs a zinc die made from a cast of the anchor tooth with its cap on. He makes of crown metal (platinum faced with gold) a collar somewhat smaller than the tooth cap, and deep enough to reach from the gum to about a sixteenth of an inch above the cap. He then drives the die into the collar so far that the extra sixteenth of an inch can be hammered over and burnished down on the die end to form a flanged collar. Outside of this, in the same manner, he forms another flanged collar and then solders the two together, thus obtaining a close fitting, stiff collar that will not stretch in being telescoped on and off the anchorage, and is kept by the flange from being forced too far over the tooth cap.

" It may be well to add that in the use of an impression-cup for holding the plaster and sand around the parts to be subsequently removed from the mouth, the *inside* of the cup should first be slightly oiled, to allow a separation of the cup when the mass is being prepared for the soldering."†

Starr's Removable Bridge.—" A piece of thin platinum plate, No. 36 gauge, a little wider than the space to be covered with the teeth, is fitted and burnished over the space between the abutment teeth which have been so trimmed that the caps described will slide on and off easily. These caps are now cemented to the platinum plate and collars made and fitted to properly fill the space between the abutment teeth. They are held in contact with each other and with the platinum plate by running melted white wax in between them. The whole piece may then be transferred from the model to the mouth, and stiff-mixed plaster and sand pressed into and over the collars and caps.

" When the plaster has set, the mass may be removed,

* *Cosmos*, XXVIII, 746. † " Am. Syst. Dent.," II, 890.

trimmed, and the wax melted away, with the result shown in Fig. 321. The lines of contact of the collars with each other, with the caps and with the plate are to be neatly soldered, when the investment may be removed, leaving the bridge as shown by Fig. 322. The free edges of the plate may then be trimmed to the margins of the collars or caps, and the whole

FIG. 321.

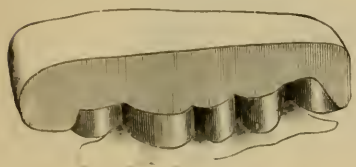


FIG. 322.

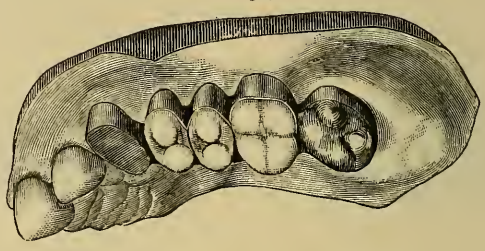
denture polished. The bridge may now be slipped on and off the natural abutment teeth with just enough of friction to retain the denture in position, and yet allow of its ready removal.

"Suitable cusp crowns (see Fig. 323) are now selected, the caps partly filled with wax, and the cusps placed in position. The denture is then tried in the mouth and the proper occlusion obtained by grinding or filling the edges of the caps. The piece is now to be thoroughly cleansed and dried; the cups nearly filled with insoluble cement or hot gutta; the cusp crowns set in the cups; the bridge put quickly in place, and the patient directed to firmly and repeatedly close the jaws, to properly determine the occlusion. It will be found best to place a piece of paper, the thickness of a postal card, over the porcelain cusps when forcing the denture to place, so as to ensure that they shall be a little short, and thus avoid irritation of the anchorage teeth in mastication. These anchorage teeth or roots will in time elongate and form a close occlusion. When the cement is properly hardened the piece may be removed. A hole should now be drilled through the

FIG. 323.

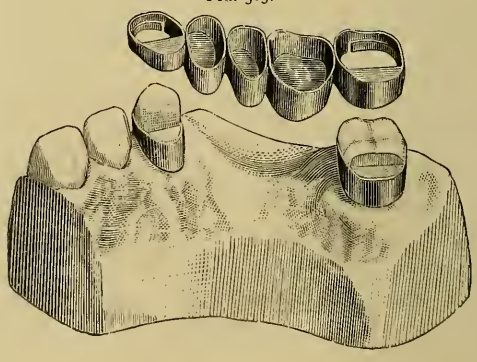
metal cups, to allow escape of surplus filling material. A small quantity of gutta-percha thoroughly warmed should now be placed in the caps, and with a piece of card placed between them and the occluding teeth, the caps should be forced home. The completed case is represented in Fig. 324.

Fig. 324.



"The bridge may at any time be removed with warmed forcep beaks held long enough on the caps to soften the gutta-percha. The cusp crowns may be removed, if desired, by the same method and replaced without detaching the bridge.

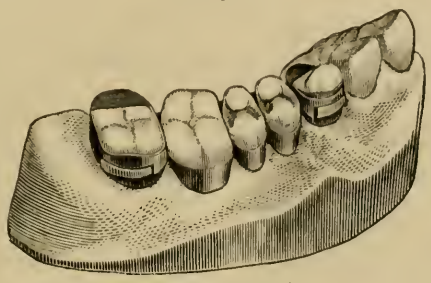
Fig. 325.



"A modified bridge is shown in Fig. 325. It will be observed that collars have been firmly fixed with cement or gutta-percha on the abutments which have their occluding surfaces ground flat on their inner aspects, so that the partial cap shown may

thus prevent the telescoping collars from being forced too far down on the teeth. By means of a frame-saw a narrow tongue is cut on the outer surface of each telescoping collar, the free portion serving as a spring clasp to hold the bridge securely on the abutment teeth, and still allow the removal of

FIG. 326.



the piece when so desired. Fig. 326 shows such a bridge in place. It is obvious that if in this instance the roots only of the cuspid and second molar had been present, they could, by means of the collar and cusp-crown devices, have been put in shape to serve as abutment teeth for the telescoping bridge shown in Figs. 325 and 326.

FIG. 327.

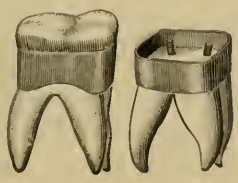


FIG. 328.

"The second molar roots so crowned are seen in Fig. 327. When it is desirable to show the faces of the porcelains to a greater degree, the collars may be cut away on the buccal sides and countersunk crowns be used, as illustrated by Fig. 328.

"The platinum base may either rest broadly on the gums or be sloped so that only the buccal border shall touch the gums, or it may be so shaped as to be entirely free from the gum. This is done by building upon the plaster cast and bending the platinum plate, and shaping the gold tubes to the surface so made, depending wholly for support on the abutment teeth or roots.

"Briefly stated, the points of excellence in this bridge are strength, lightness, avoidance of liability to breakage of the porcelain in soldering, ease of construction and adaptation, and the facility with which it may be reorganized, or for any reason be removed and replaced. This last feature is of special value in the not infrequent event of subsequent alveolar abscess, for in cases such as are shown in Fig. 326, the bridge may be removed, the involved teeth drilled, medicaments applied, the bridge replaced, and this process repeated without depriving the patient of the use of the denture."*

Repairing Crown and Bridge Work.—It is quite practicable to remove crowns and bridges for purposes of repair, and to replace them.

Any crown with soldered backing mounted on a metal post and set with cement may be readily removed by drilling a hole through the backing in the direction of the post, using first a small round bur, No. 5 or 6, and afterward one considerably larger than the post, No. 9 or 10. This will usually cut out the cap clear of the post at once. If the post be a little out of line of the hole the latter will be large enough to enable the operator to see in what direction to cut laterally to effect the purpose. If the crown has a band and does not come off readily after the post is separated, take a small round bur, No. 1 or 0, and cut the band across, when it may be opened a little and the cement loosened. With a very fine bur, No. 00 or 000, drill out the cement from the lingual side of the post, when it may be removed, leaving the root uninjured. Bend

* *Cosmos*, XXVIII, 209.

the band to place and put a new post in position, hold it with wax cement, invest, fill around the post with gold plate or foil, put a bit of gold plate in the band where it was cut, solder and finish.

To remove a cap, cut with a fine bur across the band and part way across the grinding surface if need be, and open it sufficiently to loosen it. Cleanse, refit, invest, place gold in the slot, solder and finish.

An open band may be removed in the same manner.

In a case of an all-porcelain crown, destruction of the crown seems to be the only way of removing.

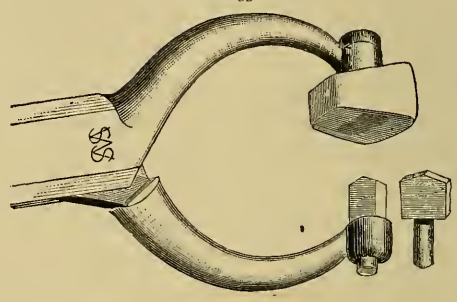
If a porcelain is broken from a bridge crown, it may be replaced without removing the bridge.

The projecting pins are cut off, and two holes drilled through the backing in the exact position occupied by the pins. The narrow space of metal now intervening between these two holes is cut out with a fissure-bur. This leaves a groove which should not be wider than the diameter of the pins. The length of this groove should now be increased on the lingual surface, but not on the front. The object of this is to give a dovetail shape to the groove, which is easily effected by the use of the same fissure-bur above referred to. The lingual appearance of this groove when properly shaped is shown in Fig. 329. The proper tooth is selected, the pins passed through this hole and bent outward into the dovetail groove. It will be found almost impossible to bend these pins into their proper positions by any ordinary means, so as to hold the tooth quite rigid and immovable. An instrument herewith illustrated (Fig. 330) accomplishes this feature of the work in a very simple and effective manner. Its use is almost too evident to require description. Both the rubber pad which rests upon the porcelain front and the wedge-shaped point which passes between the pins are made to rotate in their sockets, so that any desired position can be

FIG. 329.

obtained. A firm closure of the instrument when in position forces the pins outward into the dovetail groove, and the tooth is immovably fixed in place. It now remains but to fill the space between the pins with any form of cohesive gold (I

Fig. 330.



use crystal gold), and with corundum, Arkansas, and rubber points in the engine the surface is finished and polished. The wedge-shaped filling of gold acts as a keystone between the pins and makes a most perfect method of repair.

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* *Cosmos*, XXVII, 713.

APPENDIX.

The following are formulæ for some of the best alloys for amalgams :—

Townsend's:	Silver,	45.5
	Tin,	54.5
		100.0

A softer alloy is made as follows :—

Silver,	40		Silver,	30
Tin,	60	or,	Tin,	60
	100		Gold,	6
			Zinc,	4
				100

Alloy for a hard, quick-setting amalgam :—

Silver,	60
Tin,	35
Copper,	5
	100

For a gold alloy :—

Silver,	42
Tin,	54
Gold,	4
	100

For a copper alloy :—

Silver,	31.5
Tin,	62.5
Copper,	6
	100

The following have also proved good :—

Silver, ... 57	Silver, ... 44
Tin, ... 39	Tin, ... 51.5
Copper, ... 3	Zinc, ... 3.5
Gold, ... 1	Platinum, ... 1
100	100
Silver, ... 35	Silver, ... 39
Tin, ... 60	Tin, ... 59
Gold, ... 2.5	Gold, ... 1
Platinum, ... 2.5	Platinum, ... 1
100	100
Silver, ... 53	Silver, ... 39
Tin, ... 38	Tin, ... 58
Copper, ... 8	Gold, ... 2.5
Platinum, ... 1	Platinum, ...5
100	100
Silver, ... 42	Silver 47.5
Tin, ... 51	Tin, ... 47.5
Gold, ... 4	Copper, ... 5
Copper, ... 3	100
100	

Richmond's solder for gold coin plate :—

Fine brass wire, ... 1 part
Gold coin, ... 4 parts.*

Melotte's metal :—

Tin, ... 5 parts
Lead, ... 3 parts
Bismuth, ... 8 parts.*

Melotte's Moldine is composed of potters' clay and glycerine.*

*Evans' "Crown and Bridge Work."

REFERENCE LIST OF MEDICAMENTS USED IN OPERATIVE DENTISTRY.

Alcohol :—A general stimulant and a solvent.

Alum :—Astringent and styptic.

Amyl Nitrite :—An antidote to chloroform narcosis.

Arsenious Acid :—Used for devitalization of the dental pulp. Apply one-fiftieth of a grain.

Bicarbonate of Soda :—Antacid.

Bichloride of Mercury :—Germicide. Used in solution, 1 to 1000.

Calendula :—A soothing application to irritated pulps, or wounds of the mouth.

Capsicum :—Useful in pericementitis.

Carbolic Acid :—Antiseptic and local anæsthetic. Applied as an obtundent to sensitive dentine; to relieve odontalgia from exposed pulp, and in treatment of alveolar abscess. Oil of clove will mask its taste and odor to some extent.

Carvacrol :—May be used as a substitute for creasote and carbolic acid.

Chloroform :—Anæsthetic, and obtundent of sensitive dentine.

Cocaïne :—A local anæsthetic, and obtundent.

Creasote :—Stimulant, sedative and antiseptic. Its principal use is in inflammation of the pulp.

Eucalyptus Oil :—Antiseptic, disinfectant, and sedative. Used in treatment of teeth with putrescent pulps, and in alveolar abscess.

Glycerole of Thymol :—Antiseptic. Useful in treatment of suppurating pulps, and as a dressing in ulcers and wounds of the mouth.

Gutta-percha :—Combined with mineral substances, it is used as a plastic material for filling teeth, and dissolved in chloroform, as a capping for exposed pulps.

Hydronaphthol :—A non-irritant antiseptic, and disinfectant.

Iodine :—Stimulant and sorbefacient. Used locally in pericementitis, and inflammations of the mouth.

Iodoform :—Antiseptic, stimulant, anodyne and disinfectant. Used in combination with eucalyptus oil, or with equal parts eucalyptus oil and oil of cloves, as an application to inflamed pulps, and also as a dressing after removal of putrescent pulps, and for relief of pain following extraction of teeth affected with pericementitis.

Iodol :—Propertfes similar and uses the same as iodoform. It is somewhat questionable if it is as effective as the latter.

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